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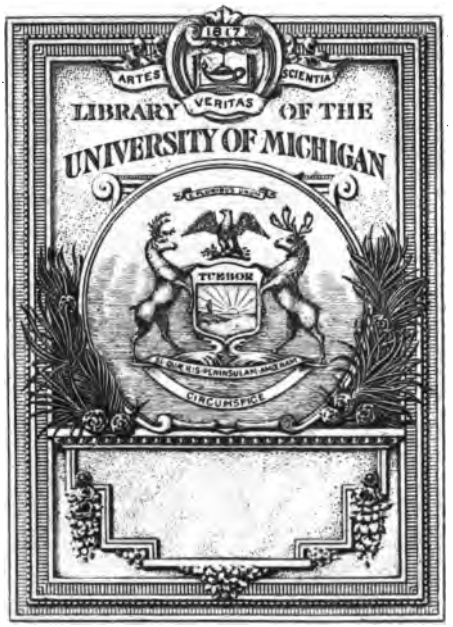
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No. LXVII. SECOND SERIES. Dec. 1807.

Specification of the Patent granted to CHARLES *Earl* STANHOPE; *for certain important Improvements respecting the Form, Construction, and Manner of building and fitting out Ships and Vessels for the Purpose of Navigation, and especially for counteracting or diminishing the Danger of that most mischievous Invention for destroying Ships and Vessels, known by the Name or Appellation of submarine Bombs, Carcasses, or Explosions.*

With a Plate.

Dated February 16, 1807.

TO all to whom these presents shall come, &c. Now KNOW YE, that in compliance with the said proviso, I the said Charles Earl Stanhope do hereby declare, that the following written description, and drawings hereunto annexed, contain a particular description of my said discovery or invention; that is to say: In the first place, the object of my said invention is to construct ships and vessels, which, as far as it is in the nature of things possible, shall unite the *maximum* of advantages with the

minimum of disadvantages; and especially with respect to the following, amongst other, important properties; *viz.* That ships and vessels constructed agreeably to my said invention shall be capable of sailing very fast, on every point on which ships in general usually sail; and shall likewise (when properly rigged) be capable of sailing very near the wind, and of weathering most admirably. That ships and vessels constructed agreeably to my said invention shall ride very easy at anchor; shall be uncommonly lively in a rough sea, and also in a head sea; and shall be what is technically called excellent *sea-boats*. That ships and vessels constructed agreeably to my said invention shall have the valuable property of drawing much less water than is usual for such ships or vessels as are of the same number of tons respectively, and as are at the same time good *sea-boats*. It is a very important fact, that the resistance of water increases gradually and regularly as the depth of the water increases, although in a less rapid ratio; so that the *minimum* of resistance to the progressive motion of ships and vessels cannot be obtained, except upon the principle of their being so constructed as not to descend into that part of the fluid, where the unalterable law respecting fluids would render the resistance so much more considerable than at a more moderate depth. To construct ships and vessels of a small draught of water, with the *maximum* of advantages, is a high and important problem, which never has been solved, to the best of my knowledge or belief, by any other person; but which I have endeavoured to solve, and I trust successfully. When the draught of water is unnecessarily great, it is highly disadvantageous in an immense variety of respects.

The object of my said invention is also, that ships and vessels constructed agreeably thereto shall have the excellent

cellent property of making less lee-way than other ships or vessels of the same draught of water; and shall have the lateral resistance to the lee-way more mechanically and more advantageously applied than in any other ships or vessels of any draught of water whatsoever; and shall moreover have the advantage of not being made to heel by means of such lateral resistance, as, in certain situations, is the case when keels are used, which, from their nature are always unscientifically placed too much below the center of gravity of the ship or vessel. That ships and vessels constructed agreeably to my said invention shall, notwithstanding their comparatively small draught of water, have sufficient stability to carry proper sail; and that they shall roll and pitch less than ships or vessels of the common construction. That ships and vessels constructed agreeably to my said invention shall be capable of keeping a true and steady course; and shall be capable of being, at pleasure, turned readily and rapidly out of their course, by means of the rudder, or by means of the gills hereinafter mentioned to be used for that purpose; and shall also be capable of coming about well in stays. And that ships and vessels constructed agreeably to my said invention (if properly rigged) shall, when sailing near the wind, be capable of having their long axis kept in, or nearer to, the intended course, than has ever yet been accomplished by any other method whatsoever.

And, secondly, the figures hereunto annexed, from 1 to 7, both inclusive, together with the explanation thereof herein given, contain a full description of *one* ship or vessel to be constructed agreeably to my said invention, in order that I may be the better enabled to explain hereinafter the nature of my said invention generally, and the manner in which it is to be performed.

Fig. 1 (Plate I.) represents the hull of a ship or vessel constructed agreeably to my said invention, supposed to be viewed from below.

Fig. 2 is a side-view of the hull of the same ship or vessel, and is that representation which is commonly called the sheer-draught.

Fig. 3 is a midship-section of the boundary of the hull of the same ship or vessel.

Fig. 4 is a perspective front-view of the hull of the same ship or vessel.

Fig. 5 is a perspective stern-view of the hull of the same ship or vessel.

In Figs. 1, 2, 4, 5, and 8, the corresponding colours * represent corresponding perpendicular distances from the lowest part of the ship or vessel. And the corresponding letters in the different figures represent corresponding parts.

Figs. 6 and 7 represent respectively an oblique section of the hull of the same ship or vessel, from U to *v* V, in Fig. 1. The difference between Figs. 6 and 7 is this: in Fig. 6 the gills hereinafter mentioned, invented by me, are represented at W *w*, down or open; whereas in Fig. 7 those same gills are represented at W *w* up, or shut. In this latter case, the outward surface of the gills is exactly flush or level with the outside of the ship or vessel, as their thickness may be let into the plank.

A gill is the reverse of a rudder. A rudder, whether of the common sort or of the equipollent species, is a thick instrument (generally of wood), that works on an axis which is vertical, or nearly vertical. Whereas a gill is a thin plate of stiff metal (that need not exceed three-eighths of an inch in thickness), and that works on an

* The colouring is necessarily omitted in the plate.

axis

axis which is horizontal, or nearly so. A gill might also be made of wood, or of any other strong substance; but metal is far preferable to wood for that purpose. That common sort of cast metal, which by many of the founders is called *strong metal*, and which is composed of ten parts of pure copper and of one part of grain-tin, when cast flat, clean, and perfect, will (amongst others) be very excellent for casting gills; as various experiments made by me with that metal, for these last twenty years, fully convince me. The gills may also be made of wrought metal, or of wrought metal combined with cast, or of a combination of metals, or of any combination of strong substances. It will be proper to make the lower edge, and also the fore and aft edges of the gills sharp, in order to diminish their resistance through the water when down or open.

In Figs. 1 and 2 a great number of gills are represented, at the head-end of the ship or vessel, between *b* and *e*, in those two figures respectively, as the gills would be seen in perspective if shut or up. Gills, similarly or otherwise situated, may be placed on the opposite side of the same ship or vessel at the head-end, and on both sides at the stern-end also. I can apply to a ship or vessel (in the same ship-planes, or in any other, fewer or more ship-planes) one set or tier of gills only, or two or more, as circumstances may require. And I can open or shut any one or more of the gills, as I find it expedient. I applied a small number of gills to a small vessel of mine, both at the head and stern, many years ago with great success; but I herein describe the true scientific method of producing a most admirable combined effect, which I believe to be without a parallel in the history of navigation. The head gills are of the most importance. But the stern gills, particularly when acting

ing in proper combination with the head gills, are likewise highly useful. Head gills, or stern gills, or head and stern gills conjointly, may be used either with the rudder or without it; and also as substitutes for the rudder, in case it should ever happen to be lost or rendered unserviceable. The head gills in particular are admirably calculated to assist a ship or vessel to weather well; and to put her head about rapidly, in critical situations, where no time can safely be lost. The larboard head gills may also be made to act in conjunction with the larboard stern gills for putting a ship or vessel about; and the starboard head gills may likewise be made to act in conjunction with the starboard stern gills to produce a similar effect. The gills may moreover be used *cross-fashion*; that is to say, the larboard head gills may be used in conjunction with the starboard stern gills, and the starboard head gills may be used in conjunction with the larboard stern gills. A parallel motion, sideways, may be given to the ship or vessel by either of those two last-mentioned methods; by which means a ship or vessel may be made to weather incomparably, and in certain confined situations might be saved, when otherwise she might perhaps be wrecked.

By means of the very advantageous parallel motion mentioned above, a ship or vessel constructed agreeably to my said invention, instead of making *lee-way*, might, on the contrary, be made to go up towards the wind, and to make *wind way*, if I may be allowed that expression. In certain cases, when the ship or vessel might otherwise become quite ungovernable, from the loss of a part of her masts and rigging, or other cause, I can use the gills, in proper combination, in order to assist in preventing her from sheering in that very dangerous manner which without such beneficial assistance she might

do

do. And this might preserve the ship or vessel from destruction when otherwise she might be lost; especially if she were to be in such distress on some dangerous lee-shore.

Each gill may be made about two feet square, or of any other proper size. Each gill should have a pair of strong hinges, or of external or internal pivots, at its upper side, by which it is to be connected to the side of the ship or vessel. One advantageous mode of opening and of shutting the gills is as follows: the line W *u*, in Figs. 6 and 7 respectively, represents the side-view of a bar, which I term the gill-bar, which is screwed or riveted to the inside of the gill W *w*, or is cast with it; which gill-bar W *u* is moved from the inside of the ship or vessel. In order to prevent the water of the sea from getting into the ship or vessel through the aperture in the plank through which the gill-bar passes, there is fixed in the inside of the ship or vessel, at each gill, a water-tight vessel of wood, or of any proper metal (such as copper) within which the gill-bar is made to move or act, whilst it is performing the operation of opening or of shutting the particular gill connected therewith, in the manner above explained. The above-mentioned water-tight vessel is only about four inches wide, inside measure, in the fore and aft direction of the ship or vessel. It may be flanched on to the inside of the plank through which the gill-bar passes by means of flanches, placed fore and aft upon the said water-tight vessel. Every other gill may be opened or shut in a similar manner. The dotted lines in Figs. 6 and 7 respectively, represent the said water-tight vessel. I have different methods of moving the gill-bar from the outside of the water-tight vessel within which that gill-bar is inclosed. But one of the best ways is by means of an horizontal stuffing-box in the side of the said water-tight vessel,

vessel, through which stuffing-box an axis should pass. The communication between the hand or other moving power and the gill-bar may then be made by levers, connected with the said axis, or by racks, or by any other well-known method, or otherwise howsoever. I can also use vertical or sloping stuffing-boxes, or I can use stuffing-boxes with pulling or pushing bars, or I can even use long pipes, open at their upper end, without any stuffing-boxes; but the above-mentioned method, by means of stuffing-boxes, is the method that I should prefer.

In Figs. 6 and 7 respectively, one very simple and equipollent method of performing the said operation is represented. In those two figures *z* is the axis above mentioned. The line *z k* represents a lever, fixed thereon, on the outside of the above-mentioned water-tight vessel. A catch or catches, or other convenient fastening, may be applied to that lever, or otherwise, in order to keep each gill either open or shut, as occasion may require. The line *z x* represents another lever, fixed on the said axis, in the inside of the same water-tight vessel. This last-mentioned lever *z x* communicates with the gill-bar by means of a bar *x u*, which has a joint at each end of it. Levers, or other communications, might be led from the gills to the pilot, or other officer, on the upper deck, or elsewhere; or a man or lad may be stationed near the different sets of gills. The word of command may be given to the gill-attendant, or gill-attendants, through speaking-tubes, or otherwise, from any part of the ship or vessel. The gills invented by me, and described above, are not indispensable parts or appendages of a ship or vessel constructed agreeably to my said invention; but they may be most advantageously and most usefully applied or fitted thereto.

And,

And, thirdly, the nature of my said invention consists in a new form and construction of ships and vessels, and in a new and scientific combination of proper horizontal and vertical ship-lines, as described above, or founded on the same principles. And my said invention consists also in a new method of rendering a ship or vessel (when properly rigged) capable of sailing uncommonly near the wind, and of weathering in a manner superior to any other ever yet practised. And this I propose to accomplish by means similar to those above described, or to some of them, and to be used to the extent necessary to produce the very desirable effect above mentioned. And the proper mode of accomplishing this grand object last mentioned, is by means of the very extensive head and stern ship-planes contrived by me, and placed, with respect to the other parts of the ship or vessel, in a proper situation and direction, as described above. And it is a circumstance peculiarly fortunate, that the very form and construction which I have invented, and which I have discovered to be the most advantageous for ships and vessels, supposing that the gills invented by me be used, is likewise the exact form and construction which is the most scientific and the very best for ships and vessels, exclusive of the use of gills. And all such ships and vessels as shall be constructed agreeably to my said invention I shall term "*Stanhope Weatherers*," in order to distinguish them from all ships and vessels built upon any other principles of naval architecture whatsoever.

As ships and vessels constructed agreeably to the principles of my said invention may be of an immense variety of sizes, from a boat to a ship of the greatest burthen, and may also, in some cases perhaps, require to be made deeper in their hold, or to be otherwise varied in the relative dimensions of their respective parts, in order to

answer some particular purpose or purposes in the best manner possible; I can vary the dimensions specified above, both absolutely and relatively; I can increase or vary the length of the midship-body; and I can likewise vary the horizontal and the vertical ship-lines, and the number, direction, and inclination of the gills, without departing from the true principles of my said invention. But a great or violent deviation from the specific species of ship-lines, delineated in the figures above mentioned, will not be desirable.

It will be advantageous to have a deck at each height where a gunwale is represented in Figs. 2, 3, 4, and 5; but I can incline the part wale-reared, or omit it entirely. By continuing the oblique sides of the ship or vessel higher up, or otherwise, I can so increase the breadth of her deck as to bring her within the statute dimensions of one foot in breadth for every three feet and a half in length. I can also add various upper works when required. I can also make all the decks exactly level, by comparatively raising the middle of the deck or decks: or I can omit the sheer of the aft part only of the ship or vessel, by keeping the upper lines represented in Fig. 5 as low as the corresponding lines represented in the midship section Fig. 3, or otherwise howsoever. I can also introduce some convex, or even some hollow horizontal ship-lines. I can either use a common rudder or the equipollent rudder, which was above seventeen years ago invented by me, and executed soon after with success; or I can even use the gills instead of any rudder whatever. And I can likewise apply a keel or keels to a Stanhope-weatherer, especially if she shall be of a small size; although, generally speaking, I disapprove of any keel, for the reasons assigned above. And I can likewise make sundry other alterations and variations without

without at all departing from the true principles of my said invention.

And, fourthly, the manner in which my said invention is to be performed, is as follows: but I declare generally, and once for all, that, as to the mere manner hereinafter mentioned of executing the work (even where such manner is new, and contrived by me), I claim no exclusive privilege relative to such mode or manner of executing the work. I can build the ship or vessel in any one of the most approved methods heretofore practised, or in any other sufficient manner, by means of which the proper scientific form can be obtained. I can, as usual, build her with planks placed on the inside of the ribs or timbers, as well as with planks placed on the outside of them; or I can build her without the common inside planking, by proportionably increasing the thickness of the planks which are on the outside of the ribs or timbers. This latter method is the antient method; and, in my opinion, it ought again to be revived. It is very far preferable to that prejudicial modern mode of ship-building by means of double planking, by which the ribs or timbers are excluded from the fresh air, and become thereby much more liable to decay.

The following most important fact is reported by the commissioners of the land revenue in their eleventh report, *viz.* that "the medium duration of the ships which compose the present navy, taken one with another, is only about eleven years and three quarters." This fact does, in my opinion, clearly prove the absurdity of the present practice. Besides, a given quantity of plank, in thick-stuff, placed wholly on the outside of the ribs, will be considerably stronger than the same quantity of plank in two thinner planks, part placed on the outside of the ribs, and the remaining part placed on the inside

of them. Besides, by reviving the antient method of single planking much expense of sawing, and of tree-nailing, and of other labour, would be saved. Besides, it is evident, that outside planks of thick-stuff, six inches thick for example, would not require that the ribs or timbers should be placed so near to each other, as in the case of the outside planks of a ship or vessel being only from three to four inches in thickness. So that the antient method of thick planking being revived, would, on a moderate computation, save upwards of one-third of the ribs of a ship or vessel of any given size, and yet add very considerably to her strength. Besides, that antient method has also the great advantage of being much more safe with respect to accidents from fire; inasmuch as the outside planks, when in contact with the water, cannot burn; but this is not the case with respect to planks placed on the inside of the ribs, and surrounded by air. Besides, ships or vessels, by being only single planked, would be much less likely to be infested with vermin, and would be more healthy for the crew. Besides, ships or vessels, by being only single planked, would be much less liable to those tremendous dangers to which, from their being built on the modern construction, they are evidently exposed, by reason of their timbers becoming frequently, unperceived, in a state of decay. Now, it is evident that there is no form of ships or vessels whatsoever which can be equally advantageous as that of the Stanhope-weatherers above described, in respect to the obtainment of the various advantages last mentioned. Besides, the form of the said weatherers is peculiarly well calculated to assist the introduction of an improved mode of coppering ships and vessels. It is obvious that ships and vessels of the common form (or of any form approaching thereto), with curved vertical ship-

lines,

lines, combined with curved horizontal ship-lines, cannot have sheets of copper, or of any other proper metal, applied to their bottoms in the intimate manner which is necessary for perfection. I myself did, above sixteen years ago, make the following observation. I was then visiting a yard of one of the ablest ship-builders in this country. There was a vessel on the stocks. His men had nearly finished coppering her bottom. I asked, and obtained his permission, to drive the end of my walking-stick into her copper sheathing. The stick entered into the thin copper sheet with nearly the same ease that it would have entered into a thick sheet of strong brown paper; and by driving my stick on forcibly, in an oblique horizontal direction, I ripped the sheets of copper, for several feet in length, with great ease.

A Stanhope-weatherer is capable of being coppered in a very superior style, as hereinafter mentioned. About the year 1777 I invented an excellent composition (but to which I do not wish to claim any exclusive privilege), which composition I have frequently applied to various useful purposes. It is composed of three measures of pounded chalk, very dry, or dry brick-dust, and of one measure of thick (but not ropy) vegetable tar, first well mixed, and then boiled together to the consistency of bees-wax. About the year 1794 I caused the deck of the Kent, an ambi-navigator vessel of my invention (which was about one hundred and eleven feet in length), to be covered with that chalk-tar composition; and I should recommend it, or the said brick-tar composition, to be used for the decks of the weatherers invented by me. In the year 1790, and since that period, I have used that same sort of composition for covering the bottoms of some small vessels in various ways, and for applying sheathing. I should also recommend that the said composition,

or

or some other proper substitute, be used in the following manner, for coppering the bottom of a Stanhope-weatherer, supposing that copper sheathing be used. A thin coat of the composition, about the thickness of a shilling, should in dry weather be laid hot, with a hot thick trowel, on the planks to be sheathed. But no brown paper should be applied, as is too often most absurdly practised. A similar thin coat should be laid hot on that side of the copper which is intended to be next to the planks, the sheets of copper having first been made moderately and regularly hot. A thick coat, about one quarter of an inch thick, should then be trowelled on, over the first coat which was laid upon the planks. The hot sheets of copper should then be rapidly applied, and should be made to bed as flat and as firmly as possible, by means of flat wooden mallets. The brick-tar composition is that which I should prefer for that purpose. The sheets of copper should be lapped over each other about two inches, and they should be nailed through the said lap as usual. This should be done whilst the composition is still hot. I should also recommend that wrought-iron knees, such as have long since been applied in building the ships of the East India Company, should be used for holding together the timbers of a Stanhope-weatherer.

Another great advantage of a ship or vessel constructed agreeably to my said invention is, that the planks or thick-stuff, when properly tree-nailed or bolted, and caulked, or rabbeted, will not have the same degree of pernicious tendency to start from the ribs, or to spring a butt, as is the case with respect to ships and vessels of the common construction. That fatal accident has been supposed to have been the cause of the loss of many ships and their crews. By an analytical experiment which I made in the year 1790, on a vessel (about fifty feet in length)

length) before and after she was planked, it was clearly proved that the principal strength of ships and vessels results not near so much from the ribs and timbers as from the planks thereof. I do not approve of building ships and vessels with horizontal timbers in lieu of ribs, nor of building them with horizontal timbers and slight ribs, as some persons have proposed. I approve of stout ribs: but there need not be so great a number of ribs, of equal strength, in the case of single as in the case of double planking being used. The tree-nails should not (as is too much the usual practice) be driven quite perpendicular to the surface of the plank; but the outside end of each tree-nail should be made to incline a little towards the outside edge of the plank to which it is the nearest, or else the tree-nails should be inclined in some other direction; but they never should be at right angles to the face of the plank. In caulking decks in the usual manner, one great inconvenience afterwards happens. The power of the caulking-irons is often superior to the power of the nails or spikes of the deck-planks. This tends to drive the planks outwards; and it has likewise the pernicious tendency to drive outwards also the very sides of the ship or vessel. In order to prevent this great evil, it would be well to have two planks, each of them one inch thicker than the rest, and to let them an inch into the deck-beams, towards the two extremities, but not quite at the two extremities of the deck. Even more than two such thick planks might be used with advantage. To every deck a like method may be applied.

A great many years ago I made use of a plan, founded on the same principle, for another strong purpose, and it answered most admirably. Thick-stuff, one inch thicker than the other planks of the bottoms and sides respectively, might with peculiar advantage be similarly applied

plied both to the bottom and to the sides of Stanhope-weatherers; and this last-mentioned method I should recommend to be adopted.

Another great advantage attending my new plan for a ship or vessel is, that it will save almost all the moulds, as very few will ever be required. In any case when a Stanhope-weatherer shall be of considerable length, the strongest way to build her would be, to place a stout tabled bulkhead, ten or twelve inches thick, in the centre of the ship or vessel, right fore and aft. The bulkhead may be tabled in the usual way of tabling, or (which is still better) in Mr. Marmaduke Stalkartt's mode of tabling, which is as follows. Instead of putting the beams together, by dividing the tabling in the middle of each beam, the beams should be tabled together in dove-tails, and taken through from side to side. No kersy or flannel should be put in the scarfs; for that practice, by retaining the moisture, tends to rot the beams, as the most experienced ship-builders well know. The said tabled bulkhead may be of oak; or, to save oak-timber, it may be of elm, or other wood fit for the purpose. It ought also to extend from the bottom timbers and planks of the ship or vessel to the height at least of the first deck above the load-water-line. It ought also to extend from the stern-cabin to the raking-stem. This bulkhead is not necessary; but it would be very beneficial. It may be tabled in any other mode of tabling; or it may be applied, though with much less advantage, even without any tabling at all. That centre plank of the bottom which is right under this bulkhead, ought to be at least three inches thicker than the other planks, or other thick-stuff of that flat bottom. It ought, on the outside of the ship or vessel, to be either quite flush with the rest, or nearly so. But in the inside of the ship or vessel it should

should be sunk one inch deep into the thwart horizontal floor-timbers of the flat bottom. And those thwart horizontal floor-timbers ought also to be sunk into it full two inches deep, by means of a broad notch cut in such thick plank, at each such floor-timber. A similar plan to this might with great propriety be adopted with respect to the other thickest planks to be applied, as above mentioned, to the horizontal part of the bottom of a Stanhope-weatherer. If such tabled bulkhead as is mentioned above were to be properly caulked, and were to be strongly joined to a sufficient number of thick or thin thwart bulkheads, properly caulked also, and strongly connected to the two sides of the ship or vessel, great additional strength, and uncommon security, would be obtained thereby.

This incomparable method of executing the work might save thousands of lives, and millions of property; for if the bottom of this ship or vessel were to be essentially injured in any one particular place (by which sort of injury any common ship or vessel would infallibly be sunk), one only perhaps of the small rooms, cabins, or chambers, formed by means of the bulkheads above mentioned, would fill with water; but the remaining chambers would prevent the ship or vessel from sinking, and would save the lives of the crew. If the ship or vessel has ports, thwart bulkheads under the lower ports, or under most of them, would be advantageous. The common mode of caulking ships and vessels is highly improper. The oakum, unless it be for caulking the decks or thwart bulkheads, should never be of that sort which is made of old cables or junk; but it should all be of that sort which is made from new hemp, if intended for caulking either the bottom or the sides of a ship or vessel, or the fore and aft tabled bulkhead. Neither should it be

driven only a little way into the joints between the planks or thick-stuff, as that practice tends to deprive the planks or thick-stuff of a great part of their mutual support; upon which mutual support, however, the chief strength of a ship or vessel depends. Particular attention should also be paid to the shape of the caulking-irons; for if the sides of those irons be much out of parallel, they tend to cripple the planks or thick-stuff in the act of caulking them.

If it shall be thought proper in building a ship or vessel constructed agreeably to my said invention, to apply it to my improved equipollent rudder, the best way will be to form the stern of the ship or vessel in the manner represented in Figs. 1, 2, 5, and 8, respectively; and to make the rudder, and its appendages, of the form represented by *o* O T *t* Y X *y* Z *r t*, in Fig. 8, where Z *y* represents a chain of two or more links, connected to the ship or vessel at Z, and connected at *y* to two broad flat united bars, which are to be so made as to clip the rudder from *y* to Y; which rudder has one notch at *y*, and another notch at Y, in order to keep those united bars in their proper place. The use of this chain Z *y* is to prevent ropes from getting between the rudder and the ship or vessel. Those united bars may be shipped upon the rudder after it is actually in its place, which is a great convenience attending this improved construction invented by me.

A Stanhope-weatherer is particularly well calculated to counteract or to diminish the danger of submarine explosions, on account of her various and remarkable combined properties above mentioned, arising (amongst other things) from her form, her small draught of water, her general and also local strength, and her various rooms, cabins, or chambers. I have likewise co-operating methods,

thods to produce the same effect. From long spars, placed on the deck, and inclined both forwards and outwards, I can moreover outrig her prow, at several yards before the stem, by means of ropes, metal bars, common chains, or chains with long links; two of which should be placed vertically before the prow; two more of which should extend vertically or obliquely several feet beyond the line of her sides; and one other of which should extend horizontally three or four feet below her bottom. These contrivances I call *protectors*; as they may tend to afford protection against that most mischievous invention for destroying ships and vessels, known by the name of submarine bombs, carcasses, or explosions *. I can place protectors, with buoys on or near the cable, when a ship or vessel rides at anchor, in order to protect the cable, as well as the ship or vessel itself.

There are other machines of my invention, by means of which one single ship can sweep many square miles of water in a short time, in order to counteract and explode the trigger-carcasses. I term these last-mentioned counter-acting machines *straddlers*, because they are so constructed as to accompany a ship or vessel on her voyage, following her, and yet sheering or straddling sideways at the same time. A straddler consists of a long thin horizontal board on edge, sunk to any required depth below the surface of the water, and kept in that position by means of metal ballast fastened to its lower edge. The board so ballasted, is prevented from sinking by means of two large corks, which swim on the surface of the water. One of those corks is connected, by means of a line, to one end of the board on edge above mentioned; the other cork is similarly connected to its other end.

* For a description of a machine of this nature see vol. XV. of the 1st series of this work, page 385. Ed.

The board has head and stern rudders, fixable at any proper angle which may be found by experience to be the most advantageous; by which means the board on edge (which is as many feet under water as may be required), when towed after a ship or vessel, will straddle very wide sideways. Two such straddlers may be used. I distinguish them by the names of the starboard straddler and the larboard one. They are both towed from one and the same iron bar, placed at the stern end of the ship or vessel. Those two tow-lines, at the end next to the ship or vessel, ought to be kept as low under water as the boards on edge. Those two tow-lines are duly ballasted by small leads; and they are kept at an even depth below water by means of thin lines, tied at one of their ends to those leads respectively, and tied at the other end to corks, which float on the surface of the water. The two tow-lines, leading from that bar to those two opposite straddlers respectively, would then sweep the whole space between them, as the ship or vessel proceeds on her voyage. This might afford protection to other ships or vessels which might follow after.

But I claim no exclusive right to the use either of the protectors or of the straddlers, or of any of the species of them invented by me; as I particularly wish that all captains, or other commanders, may at all times be allowed to secure their respective ships or vessels, and all other ships or vessels which may happen to be in company, against that most mischievous invention called submarine bombs, carcasses, or explosions, by using for that purpose those two preservative contrivances of mine last described, or either of them, at their free will and pleasure, and as circumstances may be found to require.

In witness whereof, &c.

Specification

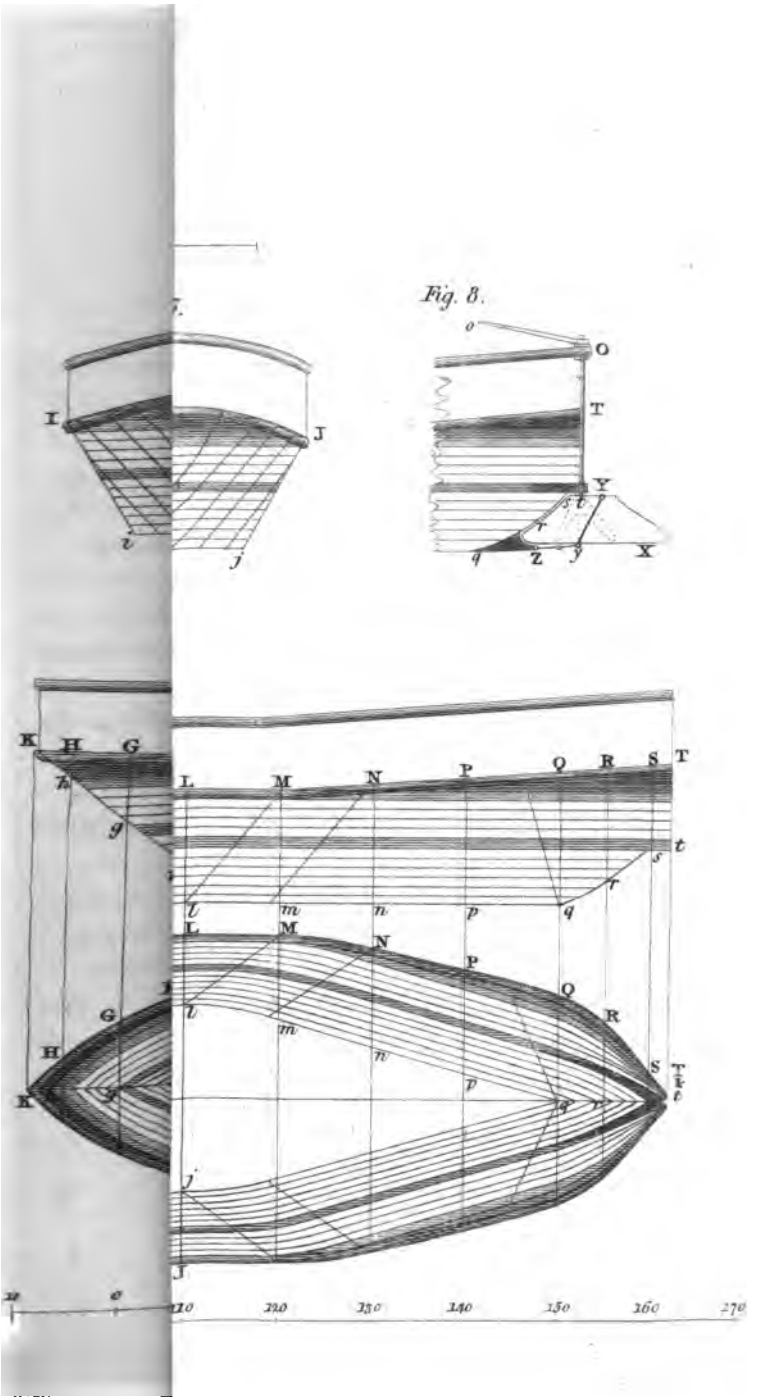
Fig. 8.
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Specification of the Patent granted to ROBERT JOHN STANLEY, *of the Town of Gainsborough, in the County of Lincoln, Gentleman; for a Method of tanning Leather without the Use or Application of Bark or Mineral Astringent (except in the tanning of Backs and Bends), yielding a great Advantage both in respect to Time and Expense, whereby as good, if not a superior, Article or Commodity is produced.* Dated April 28, 1807.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Robert John Stanley do hereby declare, that my said invention of a new method of tanning leather is described in the manner following; that is to say: That my new method of tanning does not differ from that used by tanners in general in any other respect than the saving of time and expense, the preparation of the ouze or astringent liquor, and the materials of which the same is composed, except that the hides and skins previous to their being put into the ouze or astringent liquor, hereinafter specified, are put into a preparation of bran and water, where they remain for a space of two days. That the materials of which the ouze or astringent liquor is composed for tanning of skins are Allepo galls, tormentil or sept-foil root, and Bengal catechu; and the quantities or proportions of each ingredient (of the best quality) are half a pound of Allepo galls, five pounds of tormentil or septfoil root, and one ounce and a half of Bengal catechu. That the method of preparing the said ouze or astringent liquor for tanning of skins is as follows: the above materials are powdered, and put into a copper with seventeen gallons of water, and boiled for

for such a length of time as the tanner may judge necessary: when the same is so boiled, the liquor is to be pumped out of the copper into the vat, there to remain until cold, when the skins are to be put in, and handled frequently during the three first days, afterwards to remain two or three days; then to be handled two, three, or more times in one day, as may appear necessary; then to remain undisturbed for twenty-five days, or thereabouts, according to the thickness of the skins; after which the skins are to be taken out and dried in the usual manner, and the same are then ready for the currier. That the materials of which the ouze or astringent liquor for tanning of hides is composed are the same, and in the same proportions, as for tanning of skins; but the operation is something different; for, after the hides are put into the ouze or astringent liquor, they are to be handled frequently for the first six or seven successive days, then to remain quiet for about a fortnight, and then to be taken up and handled frequently for about two or three days more; after which they are to be handled at intervals, as the tanner may judge necessary, for a space of from ten to twelve weeks, according to the thickness of the hides, and then to be dried in the usual manner. That for tanning very thick hides, for the purpose of being cut into backs and bends, it will be necessary to add to the former materials for composing the ouze or astringent liquor, the same quantity of good oak bark as of tormentil or sept-foil root.

In witness whereof, &c.

The Patentee wishes it to be known, that he is willing to grant a few licences to practise his improved method of tanning, by which full 50 *per cent.* is saved in cost, and at

at least two months in time. Any gentleman, therefore, who may be desirous to embark in a tanning concern, to be conducted according to the mode detailed in the preceding specification, may learn particulars of the terms by applying to the office of this publication.

A skin tanned agreeably to the improved mode may, the Patentee says, be seen at the Repository of the Society for the Encouragement of Arts, &c. in the Adelphi.

Specification of the Patent granted to JAMES BRADLY, *of Maid-lane, Southwark, in the County of Surrey, Ironfounder; for a new kind of Iron Bar to be used in Fire-places for Boilers, Furnaces, Hot-houses, and any other Fire-place where Bars are used.*

Dated July 13, 1807.

With an Engraving.

TO all to whom these presents shall come, &c. Now KNOW YE, that in compliance with the said proviso, I the said James Bradly do hereby declare that my said invention is described as follows; that is to say: My said invention of a new kind of iron bar to be used in fire-places for boilers, furnaces, hot-houses, or any other fire-place where iron bars are used, consists in making the same hollow instead of solid, and in leaving them open from one end to the other, so that air may pass through them; and this I perform by casting them in the way that hollow things are usually cast, and of any required shape or form: but the form which I prefer, and the dimensions in general use for large fire-

places,

places, are described in the margin hereof. (See Plate II. Figs. 1 and 2.) Care should be taken in placing these bars in the fire-place, so that the air may have free entrance and exit at both ends, by which means they will be kept cooler than solid bars, and will not be subject to be burnt and wasted like them from violent heat. But in case these bars should be placed by accident, or the carelessness or designs of the workmen, so that their ends might be closed with mortar or other substance, I make them with a hole or holes on each side, and at opposite ends, or at the lower edge of each bar, so that the air may be freely admitted into them through these openings. The advantage of making furnace-bars hollow so that the air may have a free passage through them is considerable; for, independent of their being capable by this means of enduring a greater degree of heat than solid ones without injury, they will last longer, will in a great degree prevent the coals from burning to clinkers, and may be afforded for the same and perhaps less cost in the first instance.

Reference to the Plate.

Fig. 1, (Plate II.) longitudinal view of a bar twenty-four inches long. *a*, a hole in the one side, about one inch in diameter; a similar hole is made in the other side at the opposite end.

Fig. 2, end view of a hollow bar, with the usual dimensions, one twenty-four inches long.

In witness whereof, &c.

Specification

Fig 3

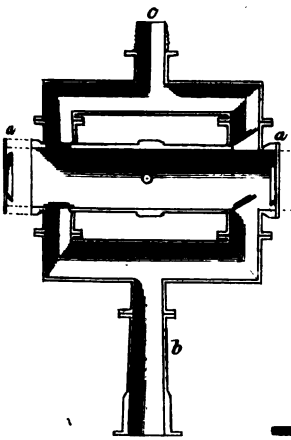


Fig. 4.

Fig. 5.

Fig. 6.

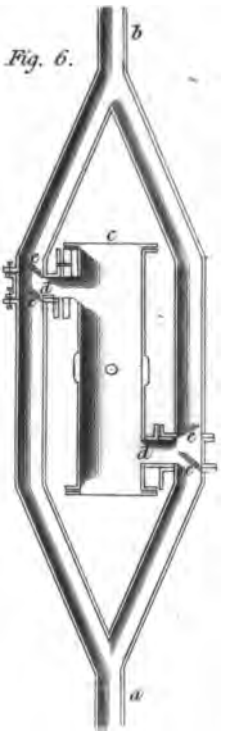


Fig. 1.

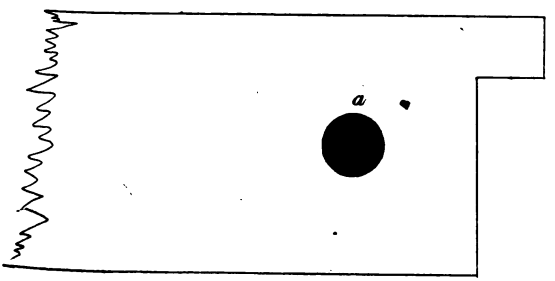
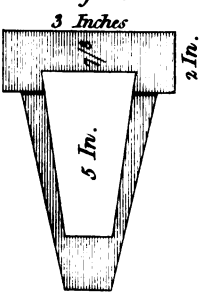


Fig. 2.



Specification of the Patent granted to JOHN NORTON, *of Rolls-buildings, Fetter-lane, in the City of London, Mathematical Instrument-maker; for a new-invented Pump.*

Dated July 13, 1807,

With Engravings.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Norton do hereby declare that my said improved pump is described in manner following; that is to say: It is constructed so that it shall produce a continued or uninterrupted stream; and this I accomplish by placing the piston or plunger, worked in a new and peculiar manner, in the working barrel (if the same be fixed horizontally), between four apertures, two of which furnish the water or other liquid from the sucking barrel into the working barrel, and the other two convey the same away into the delivering pipe. The peculiarity of the working of this piston is to make it raise the water or other liquid alternately through each of the apertures connected with the suction pipe, and to force it alternately through each of the apertures connected with the delivering pipe, whence it issues in a continued or uninterrupted stream. If the working barrel is placed vertically, two apertures will only be necessary, as may be seen in Fig. 6, (Plate II.) which represents a pump constructed in this manner.

Fig. 3 (Plate II.) is a section of the pump, with the working barrel placed horizontally, having the four apertures above-mentioned, in which the necessary valves are inserted.

Fig. 4 exhibits a section of the piston detached from the barrel.

Fig. 5 the crank by which the piston is worked backwards and forwards in the barrel.

In the centre of the working barrel, Fig. 3, is represented a pivot hole for the end of the crank to work in at the back of the cylinder. The piston is introduced into the working barrel at one end, and the crank is afterwards introduced through a hole in the front or middle of the cylinder, made large enough for that purpose, which is then covered over with a plate, screwed thereon, having a hole just sufficient to permit the crank to work through it. The space between the bars connecting the ends of the piston together should be wide enough to permit the play of the crank.

a a, Fig. 3, shew the plates that are screwed on the ends of the working barrel; *b* is the receiving or suction pipe; and *c* is the delivering pipe. *d*, Fig. 4, is the joint-piece that screws on the end of the piston at *e*; *f f* are two of the bars connecting the ends of the piston. *g* is the clams encircling the part of the crank Fig. 5, marked with the same letter. And it should be observed, that the clams ought to be fastened with screws, secured by a steady pin passing through them, so that the clams shall not become loose in working. And, note, the connecting rod may be made to work by a ball and socket, as a universal joint, instead of the method shewn in the drawing, care being taken to secure it from getting loose from the clams by a pin being passed through the ball and cup.

Fig. 6 exhibits my improved pump with the working barrel placed vertically, and having only two apertures; *a* the receiving or suction pipe; *b* the delivering pipe; *c* the working barrel; *d d* the two apertures in the working barrel; *e e e e* the necessary clacks or valves.

In witness whereof, &c.

On

On the Economy of Bees. In a Letter from THOMAS ANDREW KNIGHT, *Esq. F. R. S. to the Right Hon. Sir* JOSEPH BANKS, *Bart. K. B. P. R. S.*

From the PHILOSOPHICAL TRANSACTIONS of the ROYAL SOCIETY.

IN the prosecution of those experiments on trees, accounts of which you have so often done me the honour to present to the Royal Society, my residence has necessarily been almost wholly confined to the same spot; and I have thence been induced to pay considerable attention to the economy of bees, amongst other objects; and as some interesting circumstances in the habit of these singular insects appear to have come under my observation, and to have escaped the notice of former writers, I take the liberty to communicate my observations to you.

It is, I believe, generally supposed that each hive, or swarm, of these insects remains at all times wholly unconnected with other colonies in the vicinity; and that the bee never distinguishes a stranger from an enemy. The circumstances which I shall proceed to state will, however, tend to prove that these opinions are not well founded, and that a friendly intercourse not unfrequently takes place between different colonies, and is productive of very important consequences in their political economy.

Passing through one of my orchards rather late in the evening in the month of August, in the year 1801, I observed that several bees passed me in a direct line from the hives in my own garden to those in the garden of a cottager, which was about a hundred yards distant from it. As it was considerably later in the evening than the

time when bees usually cease to labour, I concluded that something more than ordinary was going forward. Going first to my own garden, and then to that of the cottager, I found a very considerable degree of bustle and agitation to prevail in one hive in each: every bee, as it arrived, seemed to be stopped and questioned at the mouth of each hive; but I could not discover any thing like actual resistance, or hostility, to take place; though I was much inclined to believe the intercourse between the hives to be hostile and predatory. The same kind of intercourse continued, in a greater or less degree, during eight succeeding days, and though I watched them very closely, nothing occurred to induce me to suppose that their intercourse was not of an amicable kind. On the tenth morning, however, their friendship ended, as sudden and violent friendships often do, in a quarrel; and they fought most furiously; and after this there was no more visiting.

Two years subsequent to this period I observed the same kind of intercourse to take place between two hives of my own bees, which were situated about two hundred yards distant from each other: they passed from each hive to the other just as they did in the preceding instance, and a similar degree of agitation was observable. In this instance, however, their friendship appeared to be of much shorter duration, for they fought most desperately on the fifth day; and then, as in the last mentioned case, all further visiting ceased.

I have some reason to believe that the kind of intercourse I have described, which I have often seen, and which is by no means uncommon, not unfrequently ends in a junction of the two swarms; for one instance came under my observation, many years ago, in which the labouring bees, under circumstances perfectly similar to those

those I have described, wholly disappeared, leaving the drones in peaceable possession of the hive, but without any thing to live upon. I have also reasons for believing, that whenever a junction of two swarms, with their property, is agreed upon, that which proposes to remove, immediately, or soon afterwards, unites with the other swarm, and returns to the deserted hive during the day only to carry off the honey: for having examined at night a hive from which I suspected the bees to be migrating, I found it without a single inhabitant. I was led to make the examination by information I had received from a very accurate observer, that all the bees would then be absent. A very considerable quantity of honey was in this instance left in the hive without any guards to defend it; but I conclude that the bees would have returned for it had it remained till the next day. Whenever the bees quit their habitation, in this way, I have always observed some fighting to take place; but I conceived it to be between the bees of the adjoining hives and those which are removing; the former being attracted by the scent of the honey, which the latter were carrying off.

On the farm which I occupy there were formerly many old decayed trees, the cavities of which were frequently occupied by swarms of bees; and when these were destroyed, a board was generally fitted to the aperture which had been made to extract the honey; and the cavity was thus prepared for the reception of another swarm, in the succeeding season. Whenever a swarm came, I constantly observed, that about fourteen days previous to their arrival a small number of bees, varying from twenty to fifty, were every day employed in examining, and apparently in keeping possession of the cavity; for, if molested, they shewed evident signs of displeasure, though they

they never employed their stings in defending their proposed habitation. Their examination was not confined to the cavity, but extended to the external parts of the tree above; and every dead knot particularly arrested their attention; as if they had been apprehensive of being injured by moisture which this might admit into the cavity below; and they apparently did not leave any part of the bark near the cavity unexamined. A part of the colony, which purposed to emigrate, appeared in this case to have been delegated to search for a proper habitation; and the individual who succeeded must have apparently had some means of conveying information of his success to others; for it cannot be supposed that fifty bees should each accidentally meet at, and fix upon, the same cavity, at a mile distance from their hive; which I have frequently observed them to do, in a wood where several trees were adapted for their reception; and indeed I observed that they almost uniformly selected that cavity which I thought best adapted to their use.

It not unfrequently happens that swarms of my own bees took possession of these cavities, and such swarms were in several instances followed from my garden to the trees: and they were observed to deviate very little from the direct line between the one point and the other; which seems to indicate that those bees which had formerly acted as purveyors, now became guides.

Two instances came under my own observation, in which a swarm was received into a cavity, of which another swarm had previous possession. In the first instance I arrived with the swarm, and I could not discover that the least opposition was made to their entrance: in the second instance, observing the direction that the swarm took, I used all the expedition I could to arrive first at the tree, to which I supposed they were going, whilst a servant

servant followed them; and a descent of ground being in my favour, and the wind against them, I succeeded in arriving at the tree some seconds before them; and I am perfectly confident that not the least resistance was opposed to their entrance.

Now it does not appear probable that animals so much attached to their property as bees are, so jealous of all approach towards it, and so ready to sacrifice their lives in defence of it, should suffer a colony of strangers, with whose intentions they were unacquainted, to take possession, without making some effort to defend it: nor does it seem much more probable that the same animals, which spent so much time in examining their future habitation, in the cases I have mentioned, should have attempted in this case to enter without knowing whether there was space sufficient to contain them, and without any examination at all. I must therefore infer, that some previous intercourse had taken place between the two swarms, and that those in the possession of the cavities were not unacquainted with the intentions of their guests; though the formation of any thing like an agreement between the different parties be scarcely consistent with the limitations generally supposed to be fixed by nature to the instinctive powers of the brute creation.

Brutes have evidently language; but it is a language of passion only, and not of ideas. They express to each other sentiments of love, of fear, and of anger; but they appear to be wholly incapable of transmitting to each other any ideas they have received from the impression of external objects. They convey to other animals of their species, on the approach of an enemy, a sentiment of danger; but they appear wholly incapable of communicating what the enemy is, or the kind of danger apprehended. A language of more extensive use

use seems, from the preceding circumstances, to have been given to bees; and if it be not, in some degree, a language of ideas, it appears to be something very similar.

When a swarm of bees issue from the parent hive they generally soon settle on some neighbouring bush or tree; and as in this situation they are generally not at all defended from rain or cold, it is often inferred that they are less amply gifted with those instinctive powers that direct to self-preservation than many other animals. But their object in settling soon after they leave the hive is apparently nothing more than to collect their numbers; and they have generally, I believe always, another place to which they intend subsequently to go: and if the situation they select be not perfectly adapted to secure them from injuries, it is probably, in almost all instances, the best they can discover. For I have very often observed that when one of my hives was nearly ready to swarm, one of the hollow trees I have mentioned (and generally that best adapted for the accommodation of a swarm) was every day occupied by a small number of bees; but that after the swarm had issued from that hive, and had taken possession of another, the tree was wholly deserted; whence I inferred that the swarm, which would have taken possession of the cavity of that tree, had relinquished their intended migration when a hive was offered them at home. And I am much disposed to doubt, whether it be not rather habit, produced by domestication, during many successive generations, than any thing inherent in the nature of bees, which induces them to accept a hive when offered them, in preference to the situation they have previously chosen: for I have noticed the disposition to migrate to exist in a much greater degree in some families of bees than in others; and the offspring of domesticated animals

animals inherit, in a very remarkable manner, the acquired habits of their parents. In all animals this is observable; but in the dog it exists to a wonderful extent; and the offspring appears to inherit, not only the passions and propensities, but even the resentments, of the family from which it springs. I ascertained by repeated experiment that a terrier, whose parents had been in the habit of fighting with polecats, will instantly shew every mark of anger when he first perceives the scent of that animal; though the animal itself be wholly concealed from his sight. A young spaniel brought up with the terriers shewed no marks whatever of emotion at the scent of the polecat; but it pursued a woodcock, the first time it saw one, with clamour and exultation: and a young pointer, which I am certain had never seen a partridge, stood trembling with anxiety, its eyes fixed, and its muscles rigid, when conducted into the midst of a covey of those birds. Yet each of these dogs are mere varieties of the same species; and to that species none of these habits are given by nature. The peculiarities of character can therefore be traced to no other source than the acquired habits of the parents, which are inherited by the offspring, and become what I shall call instinctive hereditary propensities. These propensities, or modifications of the natural instinctive powers of animals, are capable of endless variation and change; and hence their habits soon become adapted to different countries and different states of domestication, the acquired habits of the parents being transferred hereditarily to the offspring. Bees, like other animals, are probably susceptible of these changes of habit, and thence, when accustomed through many generations to the hive, in a country which does not afford hollow trees, or other habitations adapted to their purpose, they may become more dependent on man, and

rely on his care wholly for an habitation; but in situations where the cavities of trees present to them the means of providing for themselves, I have found that they will discover such trees in the closest recesses of the woods, and at an extraordinary distance from their hives; and that they will keep possession of such cavities in the manner I have stated: and I am confident that, under such circumstances, a swarm never issues from the parent hive, without having previously selected some such place to retire to.

It has been remarked by Mr. John Hunter, that the matter which bees carry on their thighs is the farina of plants with which they feed their young, and not the substance with which they make their combs; and his statement is, I believe, perfectly correct: but I have observed, that they will also carry other things on their thighs. I frequently covered the decorticated parts of trees on which I was making experiments with a cement composed of bees-wax and turpentine; and in the autumn I have frequently observed a great number of bees employed in carrying off this substance. They detached it from the tree with their forceps, and the little portion thus obtained was then transferred by the first to the second leg, by which it was deposited on the thigh of the third: the farina of plants is collected and transferred in the same manner. This mixture of wax and turpentine did not, however, appear to have been employed in the formation of combs; but only to attach the hive to the board on which it was placed, and probably to exclude other insects and air during winter. Whilst the bees were employed in the collection of this substance, I had many opportunities of observing the peaceful and patient disposition of them as individuals, which Mr. Hunter has also, in some measure, noticed. When one bee has collected its load, and was just prepared to take flight,

another

another often came behind it, and despoiled it of all it had collected. A second, and even a third, load was collected and lost in the same manner, and still the patient insect pursued its labour, without betraying any symptoms of impatience, or resentment. When, however, the hive is approached, the bee appears often to be the most irritable of all animals; but a circumstance I have observed amongst another species of insects, whose habits are in many respects similar to those of bees, induces me to believe, that the readiness of the bees to attack those who approach their hives, does not in any degree spring either from the sense of injury or apprehension of the individual who makes the attack. If a nest of wasps be approached without alarming its inhabitants, and all communication be suddenly cut off between those out of the nest, and those within it, no provocation will induce the former to defend their nest, or themselves. But if one escape from within, it comes with a very different temper, and appears commissioned to avenge public wrongs, and prepared to sacrifice its life in the execution of its orders. I discovered the circumstance, that wasps thus excluded from their nest would neither defend it, nor themselves, at a very early period of my life; and I profited so often by the discovery, as a school-boy, that I am quite certain of the fact I state; and I do not entertain any doubt, though I speak from experiments less accurately made, that the actions of bees, under similar circumstances, would be the same *.

Mr.

* A curious circumstance relative to wasps, attracted the notice of some of my friends last year, and has not, I believe, been satisfactorily accounted for. A greater number of female wasps were observed in different parts of the kingdom, in the spring and early part of the summer of that year, than at almost any former period; yet scarcely any nests, or labouring wasps, were seen in the following autumn;

Mr. Hunter conceived bees wax to be an animal substance, which exuded between the scales of the belly of the insect; but I am strongly disposed to believe that it is collected from plants, and merely deposited between the scales of the belly of the bee, for the joint purposes of being carried with convenience, and giving the temperature necessary for being moulded into combs; and I am led to this conclusion, not only by the circumstance of wax being found in the vegetable world, but also by having often observed bees employed in detaching something from the bases of the leaves of plants with their forceps, which they did not deposit on their thighs, as they do (I believe invariably) the farina of plants. I have also frequently observed the combs of very late swarms to be remarkably thin and white, and brittle; which are circumstances very favourable to the conclusion that the wax is a vegetable substance, for it would probably be less abundant during autumn than in summer; and that portion

the cause of which I believe I can explain. Attending to some peach-trees in my garden, late in the autumn of the year 1805, on which I had been making experiments, I noticed, during many successive days, a vast number of female wasps, which appeared to have been attracted there by the shelter and warmth of a South wall; but I did not observe any males. At length, during a warm gleam in the middle of one of the days, a single male appeared, and selected a female close to me; and this was the only male I saw in that season. The male wasp, which is readily distinguishable from the female and labourer, by his long antennæ and shining wings, and by a blacker and more slender body, is rarely seen out of the nest, except in very warm days, like the drone bee; and the nests of wasps, though very abundant in the year 1805, were not formed till remarkably late in the season; and thence I conclude that the males had not acquired maturity till the weather had ceased to be warm, and that the females, in consequence, retired to their long winter sleep without having had any intercourse with them.

which

which had remained on the plants till late in the season would hence become more colourless by exposure to light, as well as more dry and brittle, than when at first exuded; but were it an animal substance, there does not appear any reason why it should be more dry and brittle, or less abundant, in the autumn, than in the spring and summer. The conclusions of Mr. Hunter are, however, always drawn with so much caution, and he united so much skill and science with the greatest degree of industry, that it is not without much hesitation and diffidence that I venture to put my opinion in opposition to his authority.

A Method of heating Rooms by Steam.

By Mr. NEIL SNODGRASS, *of Johnstone, County of Renfrew, Scotland.*

With a Plate.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

Forty Guineas were voted to Mr. SNODGRASS *for this Communication.*

THE proposed mode of heating rooms will, perhaps, be most distinctly explained by a brief history of the first ideas of the memorialist on the subject; of his attempts to put them into practice; and of the successive improvements which have been suggested to him by experience.

In April 1798 he was engaged by G. Macintosh and David Dale, Esqrs. to manage a cotton mill near Dornoch, in the county of Sutherland. He remained in Glasgow for six months after this, superintending the construction of machinery for the mill. During this period he was led

to

to consider of a cheap method of heating the mill; as he had learnt that fuel was extremely scarce and dear in the country in which the mill was situated. It was evident that none of the methods which he had seen practised could be applied, but at an enormous expense; and his experience had pointed out to him important defects and inconveniences in them all. Having observed a mode of drying muslins by wrapping them round hollow metal cylinders, filled with steam, practised at the bleach-fields near Glasgow, it occurred to him, that by means of a proper apparatus, steam might be applied to heat a cotton mill, or any other large manufactory. It was evident that this not only would be an economical mode of producing heat in large works, so far as fuel was concerned, but that it would prevent the danger of fire, to which such works, when heated in the usual manner, are much exposed. He communicated his notions to a number of cotton spinners and others, from whose suggestions he expected assistance; but he met with nothing but discouragement, the project being every where treated lightly, or pronounced to be impracticable. Strongly impressed, however, with the advantages of the plan, the memorialist persevered in his resolution to make trial of it, and ordered tin pipes to be made for the purpose. These he erected in the mill in May 1799. When filled with steam they at once produced the necessary degree of heat; but the pipes, having been damaged in the carriage, proved not sufficiently strong. Indeed the memorialist was immediately sensible, that their position was unfavourable. With a view to some conveniences in point of room, they had been carried up diagonally in one end of the mill, whence the upper sides of the pipes became sooner heated than the lower, which caused an unequal expansion. The water arising from the steam condensed in the pipes in its return to the boiler, and also

obstructed

obstructed the steam in its ascent. In order to remedy these defects, the pipes were altered, and erected in a perpendicular position; and certain tubes were connected with them, to carry off the water arising from condensation. The whole apparatus, as it stood after this alteration, is represented by the drawing, Fig. 1. (Plate III.)

This drawing presents a view of an inner gable, which is at one extremity of the preparation and spinning rooms of the mill. On the other side of this gable there is a space of 17 feet enclosed by an outer gable, and containing the water wheel, the stair-case and small rooms for the accommodation of the work. In this space the furnace and boiler are placed on the ground. The boiler cannot be shewn here, as it lies behind the gable exhibited; nor is it of any consequence, as there is nothing peculiar in it. It may be of any convenient form. The feeding apparatus, &c. are in every respect the same as in the boiler of a common steam engine. A circular copper boiler, two feet diameter, by two feet deep, containing 30 gallons of water, with a large copper head, as a reservoir for the steam, was found to answer in the present instance. The steam is conveyed from the boiler through the gable, by the copper pipe B, into the tin pipe C C. From C it passes into the centres of the perpendicular pipes E E E, by the small bent copper tubes D D D. The pipes E E E, are connected under the garret floor by the tubes F F, for the more easy circulation of the steam. The middle pipe E is carried through the garret floor, and communicates with a lying pipe 36 feet in length (the end of which is seen at G) for heating the garret. At the farther extremity of the pipe G, there is a valve falling inwards to prevent a vacuum being formed on the cooling of the apparatus; the consequence of which would be the crushing of the pipes by the pressure of the atmosphere. Similar valves, K K, are placed

placed near the top of the perpendicular pipes E E; and from the middle one E, the small pipe passes through the roof, and is furnished with a valve at I, opening outwards, to suffer the air to escape while the pipes are filling with steam, or the steam itself to escape when the charge is too high.

The water condensed in the perpendicular pipes E E E trickles down their sides into the three funnels L L L, the necks of which may either pass through, or round, the pipe C, into the copper tube M M, which also receives the water condensed in C C, by means of the short tubes N N. The pipe C C is itself so much inclined as to cause the water to run along it to the tubes N N; and the pipe G in the garret has an inclination of 18 inches in its length, to bring the water condensed in it back to the middle pipe E. The tube M M carries back the water through the gable to the boiler, which stands five feet lower than this tube. It is material to return the water to the boiler, as, being nearly at a boiling heat, a considerable expense of fuel is thereby saved.

The large pipes are ten inches in diameter, and are made of the second kind of tinned iron plates. The dimensions of the smaller tubes are seen by their comparative size in the drawing, and perhaps they might be varied without inconvenience.

The apparatus erected as here described, has been found sufficiently strong, and has required no material repairs since the first alterations were made. The leading object in the instance under consideration being to save fuel, in order to derive as much heat as possible from a given quantity of fuel, the flue from the furnace, which heats the boiler, is conveyed into common stone pipes placed in the gable. These are erected so as to prevent any danger of fire, in the manner shewn in the drawing, Fig. 2. The

steam

steam with this auxiliary communicates a heat of about 70° to the mill, the rooms of which are 50 feet long, 32½ feet wide, and 8½ feet high, except the lower story and garret; the former of which is 11, and the latter 7 feet high. The rooms warmed in this manner are much more wholesome and agreeable than those heated by the best constructed stoves, being perfectly free from vapour or contaminated air.

By various experiments it appears, that the expense of fuel is scarcely one half of what is necessary to produce the same degree of heat with the best constructed stoves. The memorialist was the better able to make the comparison, since he had previously had five years experience of cotton mills on what was, at that time, reckoned the most approved plan.

After having ascertained these results, the memorialist, in 1800, drew a plan similar to that now presented to the Society, and sent it to Glasgow to his employers, who were very doubtful of the success of the scheme. They immediately published the discovery in the Glasgow newspapers, inviting cotton spinners, and others interested, to inspect the plan. In consequence of this public intimation of the method having been successfully practised, a number of cotton spinners turned their attention to it, and adopted it with various modifications, according to the convenience of their mills, or their notions of improvement.

The memorialist afforded to every person who desired it, all the information on the subject which he possessed. His general recommendations were to detach the condensed water, in returning it to the boiler, as much as possible from the steam; and where tin pipes, or others of similar strength, were used, to secure them carefully with safety valves.

There are obvious defects in the application of the principle, as practised in the instance described above. Of some of these the memorialist was perfectly aware at the time of the first construction of the apparatus, though it was out of his power to remedy them; and he has thought it proper to give a detail of the first successful experiment exactly as it took place.

From the pipes being all in one end of the house, the heat was unequally diffused, and a considerable time elapsed, after their being first heated, before it reached the other end of the rooms. But, as the mill had barely room enough for the spinning machinery, it was impossible to erect the pipes in any other situation, or to convey them along the rooms, so as to produce a more equal distribution of heat. This, however, can be so easily effected, when there are no obstacles, such as have been mentioned, that it is scarcely necessary to enter into any detail of the means. It may be barely mentioned that the memorialist has fitted up the apparatus in two cotton mills, which are now under his management, belonging to George Houston, Esq. and Co. of Johnstone, in a manner which completely distributes the heat. In one of these mills, consisting of six stories, a lying pipe of cast iron, 5 inches in diameter, is carried along the middle of the lower story, about two feet from the cieling, with a small declivity to carry off the water. This pipe heats the story in which it is placed. Tin pipes, 7½ inches diameter, communicating with this lying pipe, are carried up perpendicularly through all the floors to the top of the house at the distance of seven feet from each other, and form a line of heated columns in the middle of each room. The same general plan has been followed in the other mill. But there are several irregularities in the building, which require a little variation of the contrivances for diffusing the heat to

every

every quarter. Some of the rooms having been added since the first erection of the mill, are connected with the main body of the building awkwardly. Into these the steam is carried by lying pipes, slightly inclined, and communicating with the principal apparatus. The steam may afterwards be distributed by other pipes in any way that is thought convenient. The memorialist has found no difficulty in conveying, by such means, the steam necessary to produce the degree of heat required in every variety of situation.

In the former of the last mentioned mills, the perpendicular pipes are connected under the cieling of the garret by a pipe 2½ inches diameter, slightly inclined, the extremities of which pass through the walls of the house, and are provided with valves opening outwards. A connecting pipe, with similar valves, is placed under the cieling of the third story. These are intended for the more easy circulation of the steam: but the memorialist found, from experience, that with all these aids, the filling of the perpendicular pipes with steam was attended with some difficulty. The steam, when first thrown in, passes up the perpendicular pipe nearest to the boiler, and being specifically lighter than air, occupies the upper part of the apparatus, compressing the air in the lower part of the rest of the pipes. The resistance of the air will thus for a long time prevent the pipes from being completely heated: but this difficulty is easily obviated by having a valve or valves opening outwards, at the lowest part of the apparatus, through which the air, when compressed by the steam, is suffered to escape. In the mill just mentioned, the lying cast iron pipe in the first story is carried through the gables of the mill, and furnished with valves for the egress of the air. It is unnecessary to repeat, that the same valves serve for the discharge of the air in heating the apparatus, and of the

steam itself, when its expansive force becomes too great. In both mills each of the perpendicular pipes is provided with a valve, to prevent a vacuum; and in the second mill the lying pipes for carrying the steam into the detached rooms have each two valves, one opening inwards, and the other outwards.

Certificates of five other mills being heated in a similar manner, by the direction of the memorialist, are presented to the Society.

The application of the principle to buildings already constructed, it is presumed, will be sufficiently obvious from the foregoing details. In new manufactories, where the mode of heating may be made a part of the original plan, a more convenient apparatus may be introduced. This will be best explained by a description of the drawing, Fig. 2, which gives a section of a cotton mill constructed in a manner which the memorialist would adopt, were he to apply the steam apparatus to a new building, or any other that would permit such an apparatus from its regular constructions. In an old mill in this place, an apparatus is now erecting by the advice of the memorialist, conformable to this plan, which is likely to be generally adopted in new cotton mills.

The furnace for the boiler is shown at *a*. The flue of the furnace conveys the smoke into the cast iron stove pipes, 1, 2, 3, 4. These pipes are placed in a space in the gable intirely enclosed with brick, except at the small apertures, 5, 6, 7, 8. A current of air is admitted below at 9, and thrown into the rooms by those openings, after being heated by contact with the pipes. This part of the plan is adopted with a view to prevent, as much as possible, any of the heat produced by the fuel used, from being thrown away: It may be omitted where any danger of fire is apprehended from it, and the smoke may be carried off in any way that

is

is considered absolutely secure. So far, however, as the memorialist is able to judge, there seems to be little or no danger of fire from a stove of this construction. The greatest inconvenience of a common stove is, that the cockle or metal furnace is liable to crack from the intensity of the heat. By the continuity of the metal from the fire-place, an intense heat is also conducted along the pipes, which exposes them to the same accident. Here the smoke being previously conveyed through a brick flue, can never communicate to the pipes a degree of heat sufficient to crack them. In like manner the pipes, having no communication with the rooms but by the small apertures, cannot come in contact with any combustible substance; and, from being surrounded with air, which is constantly changing, can impart only a very moderate degree of heat to the walls. The iron supporters of the pipes may be imbedded in some substance which is a bad conductor of heat, as furnace ashes and lime, &c. The emission of heated air into the rooms may be regulated by valves. As the pipes are not exposed to cracking, there is no risk of their throwing smoke or vapour into the rooms.

The boiler *b b*, is six feet long, three and a half broad, and three feet deep. As there is nothing peculiar in the feeding apparatus, it is omitted. The boiler may be placed in any convenient situation. Where a steam engine is used for other purposes, the steam may be taken from its boiler. The pipe *c c*, conveys the steam from the boiler to the first perpendicular pipe *d d d*. There is an expanding joint at *e*, stuffed, to make it steam tight. The steam ascending in the first pipe *d d d*, enters the horizonal pipe *f f f f*, (which is slightly inclined) expelling the air, which partly escapes by the valve *g*, and is partly forced into the other pipes. The valve *g* being considerably loaded, forces the accumulating

accumulating steam down into the rest of the pipes *d d d*. The air in these pipes recedes before the steam, and is forced through the tubes *h h h*, into the pipe *m m m*, whence it escapes at the valve *i*, and the syphon *k*. The water, condensed in the whole of the pipes, passes also through the tubes *h h h h*, into the pipe *m m m*, which has such a declivity as to discharge the water at the syphon *k*, into the hot well *n*, whence it is pumped back into the boiler.

The whole of the pipes are of cast iron, except *m m m*, which is of copper. The perpendicular pipes serve as pillars for supporting the beams of the house, by means of the projecting pieces *o o o*, which may be raised or lowered at pleasure by the wedges *p p p*. The pipes are sunk in the beams about an inch, and are made fast to them by the iron straps *y y*. Those in the lower story rest on the stones *s s s s*, and are made tight at the junction with stuffing. The pipe in each story supports the one in the story above by a stuffed joint as shewn at *r*. The pipes in the lower story are seven inches in diameter; those in the higher six inches; those in the other two are of intermediate diameters. The thickness of the metal is $\frac{1}{8}$ of an inch. The lower pipes are made larger than the upper, in order to expose a greater heated surface in the lower rooms, because the steam being thrown from above into all the pipes, except the first, would otherwise become incapable of imparting an equal heat as it descends.

There is no necessity for valves opening inwards in this apparatus, the pipes being strong enough to resist the pressure of the atmosphere.

The cotton mill is 60 feet long, 33 wide, and four stories high, the upper being a garret story. In the engraving five parts out of nine in the length of the building are only shewn.

Fig. 2.

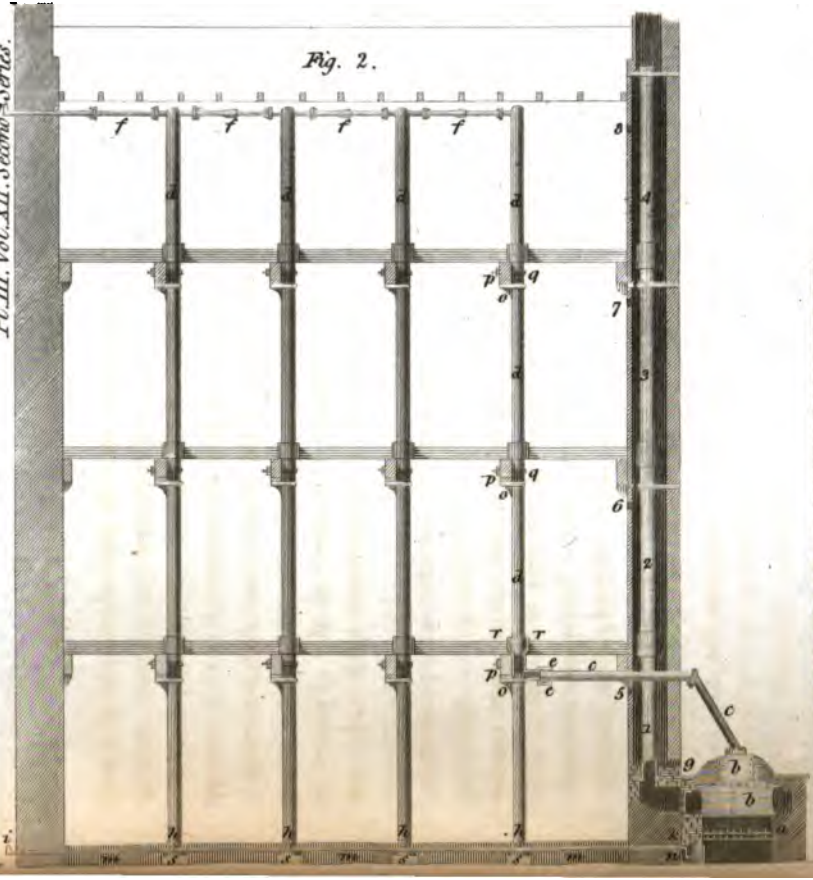
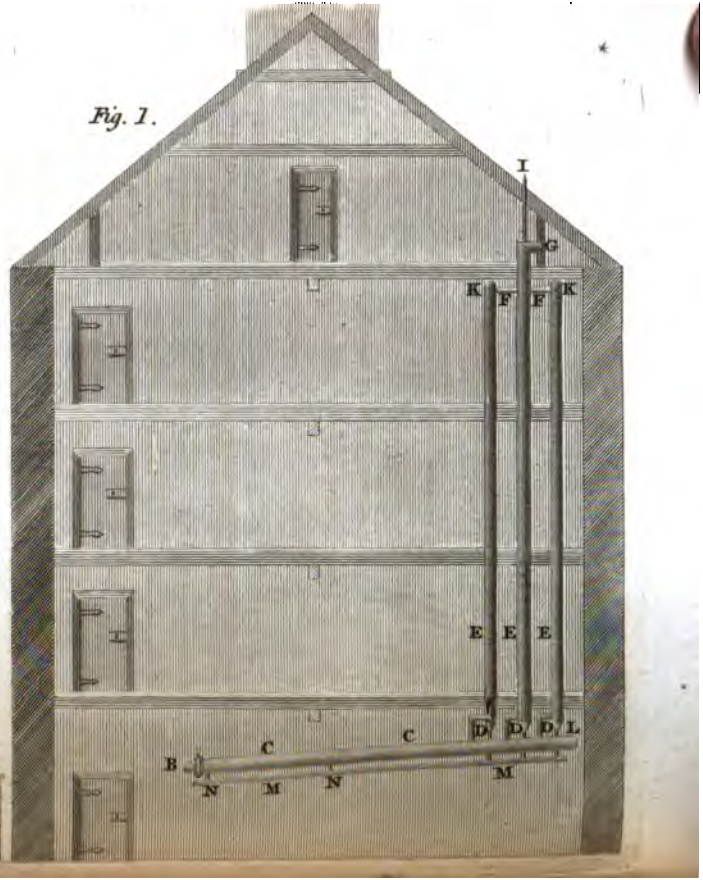


Fig. 1.



shewn. The apparatus will heat the rooms to 85° in the coldest season. It is evident that, by increasing the size, or the number of the pipes, and the supply of steam, any degree of heat up to 212° may be easily produced. It may even be carried beyond that point by an apparatus strong enough to compress the steam; this, however, can seldom be wanted. At first it was objected to this construction, that the expansion of the pipes, when heated, might damage the building; but experience has proved, that the expansion occasioned by the heat of steam is quite insensible.

The memorialist thinks it would be improper, in addressing so intelligent a body as the Society of Arts, &c. to expatiate on the various economical purposes to which the principle which he has been able but imperfectly to unfold, may be applied. In abler hands it may be found susceptible of improvement, which he cannot anticipate.

Certificates from Mr. George Macintosh, and Messrs. Henry Monteith, Bogle and Co. of Glasgow; Mr. George Houston, Messrs. Robert Hodgart and Co. Messrs. John Fife and Co. and Mr. John M'Naught, of Johnstone; Mr. James Boyle, manager for Messrs. M'Farlam, Black and Co. at Gryse-Mill; also from Mr. William Kerr, for the Lochwinnoch Spinning Company, confirm the utility and success of Mr. Snodgrass's method, and attribute to him the credit of first applying steam to the purpose of heating manufactories.

On

On the Fabrication of Alum in the Department de l'Ourte.

By G. J. CHRISTIAN.

From the ANNALES DE CHIMIE.

NOTWITHSTANDING the constant use of alum, it is astonishing that the details of its fabrication are so little known; those who have given them have always contented themselves with describing the general method of making it, without presenting the different processes employed, and which vary almost as much as the aluminous schiste itself.

The art of making alum is, in my opinion, still far short of the perfection to which it might be carried; those who have been employed in it up to this time, being acquainted with no other theory, have continued mechanically the processes employed by their ancestors, and consequently the limits of this art have not been extended; but, the processes once known, it will be easy for chemists to improve the practice by the application of theory, and by that means to assist an art so useful to society. This consideration has induced me to publish them.

In order to proceed with method, I shall treat, 1st, of the ore, the strata in which it is found, and of the general method of extracting it; 2d, of the roasting; and, 3dly, of the lixiviation, of evaporating the leys, and of the crystallisation of the alum.

I shall particularly describe the method practised at Flone, as being the best attended to and the most perfect; the general processes being in other respects the same as in other works.

Alum ores that are procured at Flone are found in beds of aluminous and pyritous schiste, at about 30 toises deep, inclined

inclined to the south about 70 degrees, and in a direction from east to west; their thickness, on an average, is 4, 6, and 8 toises.

The top of these beds is blue calcareous earth, which has the same direction as the alum ore; the schiste and mica free stone form the wall, and have the same direction.

The aluminous schiste is raised through perpendicular apertures by means of windlasses: the subterraneous works are carried on in simple galleries, lined and supported by timber and faggots.

The beds contain, in the course of their extent, two kinds of minerals; that which is on the side of the Meuse is the richest, and that on L'Hesbaye is more or less poor. The aluminous schiste, which is the richest, is ordinarily black, friable, interspersed with mica; and the finer and more divided the particles of it are, the richer is the ore.

The second kind is of a grey slate colour, sometimes covered with a reddish crust.

I shall not speak of the varieties that are met with in these two species; such details would lead me too far: neither shall I speak further of the ore that is found perished in the old galleries; it is an ore similar to the preceding, which, in the course of time, has effloresced, and its constituent principles have had time to combine. It has not the form of schiste; it is brittle, and falls into small pieces, and is of a quality superior to all the others.

The extracted ore is formed into a heap, to be left to effloresce; it is by a long exposure to the air that the schiste is brought to the state requisite for use; the half-formed, half-combined, constituent principles, combine more intimately by the action of the air and rain-water.

The workmen are fully sensible of the necessity of the assistance of the water; for when it happens, during the summer, that rain is rare, they moisten the heaps with water, which they are at great trouble to procure.

It is important that the heaps be not raised too high; if they are so, the water does not penetrate them, and the air reaches the centre with difficulty; ten or twelve feet are sufficiently high. The alum-makers are sensible of all the advantages attached to this method; but are prevented from following it in certain situations, as it requires a great space of land, which cannot be always obtained: it is often necessary to make it into heaps 40 and 50 feet high.

The friable schiste takes less time to effloresce than that of the second species. As this latter is in a mass, it is necessary, in order to facilitate the efflorescence, to break it into pieces one or two cubic inches in size, and even then it takes three or four years to effloresce. The heat of the sun, after rain, contributes much to this operation; it destroys the aggregation that unites the molecules of the schiste, and disposes its principles to combination.

They are likewise sensible of the importance of this long exposure to the air. Those who, for want of land, are obliged to employ ore not effloresced are easily convinced, by the small quantity of alum it produces, of the necessity of a longer exposure. Nature, in this case, accomplishes every thing; and renders the assistance of art unnecessary; but she must not be hurried in her operations; her progress is slow, it is true; but at the same time it is certain.

The ores, thus effloresced, are disposed for roasting.

Roasting

Roasting of the Ore.

In order to roast the ore a double bed of faggots is made, about 60 or 70 feet long and 6 wide; it is covered with a bed, about a foot deep, of the massy schiste, broken, and another foot of the scaly schiste, or first species. The first bed of the ore, by the interstices that it leaves, facilitates the passage of the heat into the second. A space of about two feet is left towards the middle of the bed of faggots; and into this space the fire is put, which afterwards spreads on all sides. While the first bed lights, a second is disposed near it, formed in the same manner. After that the first bed of ore is stirred, holes are made in it towards the surface; and above the first a second bed of faggots; and schiste is formed, which is lighted by the heat of that on which it rests. The fire is applied to the second bed, and a third is formed near it; the second is raised, and the third is lighted; a fourth is formed, while the third lights, and so on. The first bed is raised to 40 or 50 feet, and terminated in a ridge at the top. The time taken up in making these beds allows the ore of the first-formed beds to be sufficiently roasted. Those whose office is to lixiviate the roasted ore break up the heap from behind, while the workmen in front form successive beds, which are raised as I have related.

These heaps are worked about two months before the alum is made; they have always by this means a quantity of ore in advance, which is indispensable. The roasting occupies three workmen; namely, a foreman, a journeyman, and an assistant.

The heaps form the frustrum of a pyramid with four fronts, two great and two small sides; one of the large sides, on which the ore is extracted, is steep and inclining a very little to the horizon, and its reverse exhibits three

or four steps, formed by the beds that have been alternately raised.

It is important that the sides of the heap be raised as perpendicularly as possible, that the rain may not remain upon it, and carry away part of the salt; yet it is necessary that the two small sides of the heap, and the outer sides of the beds, be covered with crumbled and moist ore.

The skill of the foreman consists in roasting the earths neither more nor less than is necessary: if they are done too little they make bad alum; if too much the product is much less.

An attentive foreman ought never to lose sight of the heap; for there are accidents that diminish the intensity of the fire, such as heavy rains; and others that augment it, such as wind for example. To remedy the first accident, he ought to make an opening in the heap, wherever the fire seems extinguished, and by that means to give it air; sometimes he will find it necessary to uncover a part of a bed, and to put in fresh faggots, which must be lighted in the same manner as the former. As for the other inconvenience, he may obviate it, by stopping up with humid schiste the holes through which the flame appears. In order to roast the earths properly, the foreman should be perfectly acquainted with the degree of heat requisite for every kind of earth; for the hard require it to be stronger, and the friable rather weaker; and lastly, he must be as well able to regulate this immense fire-place, as he would that of an apartment. If any of the beds have too much fire, he must lessen it; if any others too little, he must augment it.

What I have related sufficiently shews the difficulty of the foreman's business. If he be not active, vigilant, and intelligent, he may, with very good ore, and well effloresced, produce but very little or bad alum.

The

The aluminous schiste may be said to be insipid both before and after the roasting; however, if it be previously wetted, the surface exhibits a saline vegetation, which is not pure alum; but a compost of acid sulphate of alumine, sulphate of iron, and magnesia. During the roasting, on the superficies of the beds of certain ores, an efflorescence of sulphur may be observed, and on others an efflorescence of salt entirely formed, similar to that of unroasted ore: this sulphur and this salt ultimately disappear. I propose to shew, in another place, that this proceeds from a defect in the processes; but I shall now return to the heap, which is to be cut up for lixiviation.

Lixiviation of the Ore, Evaporation of the Lixivium, and Crystallisation of the Alum.

In order to lixiviate the ore, it is detached from the lower part of the back of the heap, that the fall of the upper part may be facilitated; it is put into wheel-barrows, having the bodies made of osiers, and forming upon the barrow an inverted cone, containing about three cubic feet; it is emptied into wooden tubs, which are about 15 or 16 feet square, and are sunk about two feet into the earth. There are two bottoms to these tubs; the first is composed of planks laid upon beaten clay, and the second of boards or thick planks supported above the first, at the distance of a foot from each other: the planks are covered over, and thus a false bottom is formed, which is taken out, and cleansed when necessary. Between the false bottom and the floor of the tub there is a wooden cock for the purpose of discharging the lixivium. The tubs incline towards these cocks; the planks that are laid on the thick boards perform the office of filters, by the interstices that are left between them, and the liquor passes clear.

The

The number of tubs vary in each establishment. At Flone they are thirty, placed two by two; between which, at regular distances, are set other small rectangular tubs, which serve to contain the lixivia that runs into the reservoir, and towards which the cocks of four tubs are directed. The roasted ore is then put into these tubs; water is then let on in proportion to what may evaporate in the course of the operation, and is thus passed three times over the earth, and allowed to remain on it 24 hours each time.

He who directs the lixiviation is careful to put a less quantity of water in time of rain, notwithstanding which the lixivia are much weakened: from this circumstance it is evident that the degree of concentration of the lixivia is not always certain.

Good ore usually affords a lixivium of 18° of the areometer for salt-petre.

At this place only six tubs are filled at one time, that quantity of ore being enough to supply the establishment. If more were daily employed, the quantity of schiste extracted would be insufficient, and it would not have time to effloresce; besides the ley, which would fill a greater number of tubs, could not be evaporated.

The leys are conducted, by channels of wood, into a reservoir near the works. There they are, in a manner, under the immediate controul of the head workman, who admits them, discretionally, into the boiler; and from that into the evaporating vessels.

On the Evaporation of the Leys, and the Crystallisation of the Alum.

The apparatus for forming the alum is composed of four leaden boilers, two of which are employed in the evaporation, one to heat the mother-waters, and the fourth

fourth to heat the leys; of a cooler thirteen feet wide, fourteen long, and four and a half deep; of small crystallising tubs, four feet in length, two wide, and two deep.

The two evaporating vessels are placed on two pieces of brickwork, which rise towards the middle, and are covered with cast-iron plates, which are a foot wide and an inch thick. It is upon these plates that the boilers are placed, and which support the bottoms of them.

One vessel serves for the refining, and is only four feet wide, sixteen long, and two deep, while the other is eight feet wide, sixteen long, and eight in depth; a single fire suffices for the first, but the second requires two. The chimney of these three fires passes under the mother-water boiler, which succeeds to the two first, but rises about two feet, and beyond that is continued under the lixivium boiler.

By this arrangement, very little of the heat is lost, and the mother-waters and the leys are disposed to ebullition. It is clear that the mother-waters if not previously heated would cool the boiling considerably, and which requires much time before it arrives at ebullition. It is the same with the leys in the boiler; however, notwithstanding the advantages obtained by this method of arranging the vessels, notwithstanding the quantity of heat that is lost when graduated boilers are not used, it is not generally adopted, or at most but in part; in almost all other establishments the chimnies rise immediately from the evaporating vessels, and these chimneys become red hot at the height of eight feet.

TO BE CONCLUDED IN OUR NEXT.

Facts

Facts towards a History of Pit-Coal.

By Professor PROUST.

From the JOURNAL DE PHYSIQUE.

A COAL of Decise, after distillation by Sage, left from 59 to 60 of carbonaceous residuum of English coke. A coal of Cévenés yielded Berthollet from 76 to 77; and that from a pit in the forest of Gensane 75. I have obtained from a coal from England 64, from Lieres 60, and from Fondon, both in Asturia, 64; from Belmez, in Estramadura, 65; from Villa Nueva, near Seville, 68; from Quiros 70, Las Camaras 70, Langreo 75, La Rionda 76, and La Riosa 77, all in Asturia; from Ripoll in Catalonia, Montalban in Arragon, and Reynosa in Castile, nothing.

The environs of Madrid exhibit some vestiges of earth impregnated with bitumen, but no pit-coal, as was hoped; yet no town in Europe is at present so much in want of it. I have visited no coal-pits in Spain; except some of those in the fertile and picturesque province of Asturia. This country affords, in miniature, all of the great and sublime that the traveller admires in the Alps. The coal there generally appears in veins of little thickness, the thickest are scarcely 18 inches.

These veins which are, as in all other places, situated between strata of clay, are very variable. The pyrites spoils a great quantity; and calcination, which, it is said will desulphurate pit-coal, would hardly be capable of clearing it; whence proceeds the impossibility of establishing in Asturia such foundries as they have in England and at Mont Cenis, since they can never hope to procure from the neighbouring land a sufficient quantity of fuel to feed their vast furnaces.

Products

Products of a Hundred Pounds of some of the Coals.

Villanueva.

	lbs.	oz.	dr.
Coke	68	8	4
Condensed products	12	1	6
Gas lost	19	5	6
	100	0	0

Belmez.

	lbs.	oz.	dr.
Coke	70	13	2
Product	17	11	2
Gas	12	7	4

Langreo.

Coke	75	0	0
Product	16	2	6
Gas	8	3	2

English.

Coke	64	1	0
Product	19	14	6
Gas	16	0	2

It was interesting to compare the aqueous with the oily products after they were separated. By calculation I made the first equal to a hundred, to render the variations more sensible; and I distilled three pounds of each coal, in order that the results might be sufficiently distinguished.

Villanueva.	Aqueous product	100
	Oily	262
Belmez.	Aqueous product	100
	Oily	188
Langros.	Aqueous product	100
	Oily	188
English.	Aqueous product	100
	Oily	56

We must also compare the coke with the oil, which is as follows:

			lbs.	oz.	dr.
English	Coke - - 64 - -	Oil - -	7	0	4
Villanueva	—— - - 68 - -	—— - -	7	9	0
Belmez	—— - - 70 - -	—— - -	10	4	0
Langreo	—— - - 75 - -	—— - -	11	11	4

From these comparisons it results, that in three of these coals the oily product is more abundant than the aqueous.

2. That the weight of the gases is as variable as that of the liquids.

3. That the real quantity of coal furnished by these bituminous substances is generally above 60, and in different kinds, runs between 60 and 80.

4. That it is three times as much as our wood commonly affords; for we know of none except indigo that can be compared with pit-coal in this respect.

5. That the matter of pit-coal is as variable in its carbonaceous, oily, gaseous, and other products, as the organized bodies that are formed at present before our eyes.

6. That its oily product is generally much greater than what our resinous woods afford, such as oak, elm, ash, &c.

7. That pit-coal is thrice as advantageous in furnaces that admit of its use as any wood known, since it leaves three times as much coally matter.

8. That its coke, by reason of the azot contained in it, derives from our atmosphere much more fire than that of wood, since it cannot be burnt but by decomposing a much more considerable quantity of oxygen.

9. That the oily and gaseous products are formed as well in the open air as in close vessels. There are some coals that give a greater flame than others, and are therefore most proper for furnaces where a great current of flame

flame is required, as those of brônze, porcelain, earthenware, &c.

10. That those which leave most real coke after distillation will necessarily last the longest in forges, reverberatory furnaces, &c.

Among these four coals perhaps the richest in oil would not be the easiest to distil, at least by Lord Dundonald's method; for they melt, swell up, and agglutinate so as towards the end to become a uniform mass, that cannot be divided without labour.

The coal of Villanueva leaves only two hundredths of ashes, the colour of Vigognia wood, which indicates a coal as pure and free from pyrites as possible. It may be employed with considerable advantage in the bronze foundries at Seville, because in those works the quality of the fuel is not so material as in the making of cast-iron.

The coal of Langreo, selected, leaves no more than two hundredths of ashes, which are not more ferruginous than those of Villanueva.

That of Belmez is also of an excellent quality: we may judge by its ashes, which are not higher coloured than those of our private fire places, which indicates great purity. It melts but without augmenting in bulk, and it is well adapted for carriage, being dry, massive, and does not easily comminute; its ashes are from 6 to 7 *per cent.*

That of Quiros is also very good, tolerably pure, but scarce; it melts and swells up. The Asturias contain many other veins of a good quality, although generally in small quantities. Personal interest has suspended the hope that the inhabitants of this province had admitted, of preserving the little wood that remains in it; but time, which puts a period to intrigues, will some day restore this benefit.

All pit-coals, in general, give out more or less sulphu-

rous acid towards the end of their combustion; this proceeds from the pyrites. I returned to this idea after having at first supposed that they contained a peculiar union of sulphur and carbon; but all that I passed through nitric acid, to free them from pyrites, burned to the end without emitting the slightest smell of sulphurous acid.

The oily product of these coals, varies much in consistence; and it always requires a particular experiment to discover how much thick oil or tar it will afford. Is this tar really more preservative and better adapted for retarding the spontaneous oxydation of cordage and the rigging of ships, than that of resinous wood? This has been asserted; but should it not be further examined?

The light oil separated from it is succinated, but not disagreeable; it soon turns brown in the air, and no particular use is known for it.

The aqueous product contains carbonate of ammonia, in a small quantity. I found no vinegar in it, but I could wish to examine it again, especially as I find in my notes that I separated a little succinic acid from it, by treating it with the muriatic.

The gas is an oily hydrogen that burns with a white flame, which lime water diminishes but very little, because the ammonia retains almost all the carbonic acid.

Naturalists, reflecting on the relations that analysis discovers between the composition of vegetables and that of pit-coal, have pretty generally supposed that the latter may have been produced by heaps of fern, polypody, reeds, and aquatic plants destroyed, the impressions of which are retained by the adjacent strata; or even by trees, as their fragments, such as those which certain rivers in their inundations sometimes tear and sweep from the surface of the earth, and that the sea has transported and broken by its

its agitation, and accumulated in the basins, from whence we at present extract them. But the mechanism, the possibility even of these operations, simple as they are in appearance, are liable to innumerable difficulties, when examined in detail. For instance, those parts of the globe, which are most elevated, and on which depositions of pit-coal are found, such as the Cordillera of Peru, where Leblond met with them, being two thousand toises above the sea, are not very satisfactorily accounted for, when it is alledged that they are forests or plants swept away and comminuted by the waters. Had the sea then, at that period, no less elevated place than the Cordilleras of Peru on which to deposit its mud of triturated plants? Or, was the soil of the Cordilleras themselves particularly favourable to the production of vegetables?

These objections, which have been made by Patrin, are certainly not easy to remove. If we consider further, that these immense beds of carbonaceous mud, which resemble the torrents of melted resin that a volcano has thrown out at once upon valleys, ten, fifteen, or twenty leagues long, exhibit not the slightest interruption, not the least vestige of fishes, shells, bones or stones, nor any foreign body in their mass, nothing in short to indicate those convulsions or that disorder which the imagination can with difficulty separate from such great devastations of forests, mountains, continents, &c. we shall be forced to admit that such productions are not explicable, even by those accidents of which the system of nature sometimes actually affords us examples.

Besides that the recurrence of fifty or sixty strata of coal, and as many of sand-stone, do not permit the mind to conceive how these two kinds of sediments could have been exclusively accumulated, as if the earth could have produced

duced nothing before these periods, but what furnished the sea alternately with trees to pulverize, and silex to precipitate, and neither beast, bird, rock, flint, nor gravel could interrupt their continuity: we must likewise observe, that coal, as it is found at this day, possesses a certain number of characters that we shall presently mention, which perhaps place it at a greater distance from vegetable than animal substances.

What foundation have we then, after all, to attribute to plants the origin of bitumens? a few traces of mosses or ferns scattered through the leaves of clay that serve as their envelope? such vestiges prove at most, that Nature, at the period of these great operations, also made plants to grow, and even nourished animals in the sea, since shells are found in the strata that separate the coal in some countries; but not that it reaped from those plants sufficient materials for those inexhaustible lakes of bitumen that are scattered through our globe from pole to pole, and which generations yet unborn will, perhaps, never exhaust. They would also prove, if it could be doubted, that it did not fabricate this composition in the interior of the earth, like other minerals, but on its surface only, that is to say, in the region that it has chosen for the existence of organized bodies.

It is true, that the trunks of trees are found in veins of coal; consequently trees existed at that period. But are these trunks themselves coal? have they been analysed for the purpose of comparing their products, and of discovering whether they have experienced changes similar to those which are supposed to have been converted into pit-coal? It is easy to imagine how important the actual analysis of fossil wood may become in this respect; for if it were once to be demonstrated that a fossil trunk contains charcoal in the same proportion as the

the surrounding bitumen, and that this charcoal, besides its concentration, is combined with a fresh dose of azot, so as to have lost that prompt and easy combustibility that characterizes the charcoal of our woods, we might flatter ourselves that we possessed an argument of much weight in favour of the opinion that we seek to remove, and then we should be less surprized to find in pit-coal this astonishing result of their metamorphosis, sixty, seventy, or eighty *per cent.* of charcoal, that is to say, a proportion which, if it had been that of vegetables existing before those periods, would always have appeared difficult to reconcile with that elastic and robust organisation which our forest trees require, to raise a firm and secure trunk, and to resist the storms of an atmosphere so agitated as ours. This weak part therefore of the grand problem must soon be elucidated, if our cabinets do not delay the eagerness of chemistry to decypher the medals of this kind that they preserve; and if natural history, aided by the lights of analysis, does not succeed in discovering something more satisfactory than any thing that has hitherto been hazarded respecting the origin of pit-coal, we ought to abstain from losing our time in reasoning on this prodigious event in geology, and banish all the learned hypotheses, together with the romances on this subject which our age has produced.

I have said that analysis discovers in these bitumens characters which do not shew a greater affinity to vegetables than animals. The following are the facts. It is however for the learned, who make these things their study, to examine them, and decide on which side the balance inclines.

1. The smell that coals exhale when heated, is aromatic, succinated, and decidedly resinous; it irritates neither the eyes nor the lungs, like that of plants or wood when

when burnt; and, indeed, a balsamic property has even been attributed to this resinous smell, favourable to pulmonary diseases.

2. All coals soften, lose their shape, melt and run into the shape of the retort, and fill it with a spungy or puffy coal, like that common to mucous substances, resins, indigo, gluten and animal matters; but never like that of any plant, or of any known wood.

3. Distillation extracts from it a lighter, more aromatic, and more abundant oil, than from the non-resinous woods that are used for fuel; also much water and ammonia; but none of that vinegar which abounds so much in the distillation of our vegetables, that empyreumatic acid which renders their smoke so inconvenient and suffocating; in short, vinegar *, which is formed whenever oxygen is an integrant part of an organic oxyd, and the absence of which in the products of coal authorises us, to a certain degree, to doubt, that oxygen is one of its products.

4. The combustion of coke does not resemble that of our vegetable charcoals; it is slow and difficult like that of mineral coals, because it also contains condensed azot. It also requires to be burnt in a condensed atmosphere.

5. Coke, passed through potash, constantly yields prussic lixivium, which is not usual with vegetable charcoals.

6. Animal charcoal cannot be inflamed by nitric acid, even after it is dis-azotised by potash; neither can coke, even passed through this alkali.

* I was in doubt, for some time, whether the pyroligneous acid was really vinegar, as Fourcroy and Vauquelin have asserted; but I have now no hesitation in allowing it, because the salt I formed with oxyd of copper and the acid of elm, displayed its characters after three purifications. It gave large rhombs, differing in no respect from acetate of copper.

A mixture

A mixture of salt-petre and coke burns with as much difficulty as mixtures of salt-petre and charcoal of blood, white of egg, indigo, &c.

7. There are few kinds of wood that do not leave more ashes than pit-coal. That of Langreo and Villanueva afford but two hundredths; there are some even that do not leave more than one hundredth. Pit-coal, therefore, is not clay mixed with bitumen, as some naturalists have supposed.

8 I have not yet found oxyd of manganese in animal charcoal; and I have also sought for it in vain in the five kinds of pit-coal above-mentioned.

9 Vegetable ashes contain a great deal of carbonate of lime, beside magnesia, clay and silex. Those of the five coals I examined afforded only a great deal of silex, a little magnesia, alumine, and sulphate of lime, but very little carbonate, and particularly not an atom of those salts that are habitually contained in our vegetable ashes; no phosphate nor sea salt, although the mud of these bitumens is supposed to have been formed with sea water.

10. All the soft or liquid parts of animals contain sulphur. They cannot be dissolved in potash, without surcharging the solutions with it. Wool cannot be dipped into a bath of litharge and lime without being dyed black by it, owing to the sulphuret of lead that adheres to it.

If not any pit-coal be absolutely free from pyrites, is it not because the sulphur and iron, the two habitual elements of animal matters, have withdrawn themselves from the organic substance which is converted into bitumen, to form a separate combination?

I content myself with bringing together these facts, and I refrain from deducing any consequences from them, be-

cause they require, first, to be compared with a greater number of coals, in order that it may be ascertained whether they are as general as I think them.

But we shall, nevertheless, touch on the other properties which separate still more the analogies supposed to exist between pit-coal and vegetables.

If, for example, the carbonaceous principle be an element of their composition, in the same manner, and in the same sense, as it is in our vegetables and animals, we shall shew, that it is, however, very feebly combined in them, at least very weakly confined by the hydrogen, nitrogen and oxygen. I might almost say independent of them, since it may be obtained from pit-coal by means that would certainly never succeed with any vegetable or animal productions that we know.

TO BE CONCLUDED IN OUR NEXT.

On the most sensible Re-actives for Muriatic Acid, Carbonic Acid, Sulphuric Acid, and Ammoniac.

By Professor PFAFF.

From the ANNALES DE CHIMIE.

IN the researches on the pretended formation of muriatic acid in water by the influence of the Galvanic pile, it is without doubt of great importance to be acquainted with a re-agent very sensible to this acid, in order to be enabled to discover the first traces of it, and to follow its successive increase. Hitherto we have generally employed a solution of *nitrate of silver* for this purpose. This re-agent is undoubtedly extremely sensible to this acid. Kirwan maintains, that by this means we may even discover

cover a portion of it when diluted by 100886 parts of water; yet it is still much surpassed by a solution of *mild nitrate of mercury*, prepared cold. One part of muriatic acid, or 1.15 of specific gravity, diluted with 70000 parts of water, is feebly announced by a slight opaline hue; when diluted with 80000 times its weight of water, it is concealed from this re-active, as well as all others, except *mild nitrate of mercury*, which *very sensibly* troubles the water also weakly acidulated. The sensibility of *this re-agent* goes so far, that even $\frac{1}{700000}$ of a grain of muriatic acid of 1.15 is announced by a slight thickness in the water, containing this infinitely small quantity. By reflecting on the (I may say) absolute indissolubility of mild muriate of mercury, I have been led to the experiments concerning this re-agent.

It is also at the same time the most sensible re-agent for *ammoniac*. One part of the latter, diluted with 80000 parts of water, is discoverable by a slight blackish yellow shade, by the addition of the solution of nitrate of mercury at the minimum of oxydation.

Lime or barytes water is generally regarded as the re-agent most sensible to *carbonic acid*. I have found that the solution of *acetate of lead* surpasses them. I was accidentally led to observe this fact; some distilled water that I had kept in a cellar not very deep, and in which there were no other fermented liquors, was rendered very sensibly turbid by the addition of this dissolution. Kirwan has stigmatised the *acetite of lead* as being deceitful, because its dissolution, principally when a little stale, is sometimes rendered turbid with pure distilled water. But it is not deceitful, for the water is not pure; as it always, when this is the case, contains a little carbonic

acid. I have prepared distilled water entirely free from carbonic acid, and have never found that it became turbid either with lime-water or the solution of acetite of lead. I have treated it with a few drops of carbonic acid, and the water was so weakly acidulated, that it did not at all redden turnsol paper, nor render lime-water turbid. But the solution of acetate of lead was very sensibly whitened. The acetate of lead is much less sensible to other acids. A solution of sulphuric acid, of 1.85 diluted with 160000 parts of water, which acts very sensibly on turnsol paper, is not troubled by the acetate of lead. It is barytes-water that discovers $\frac{1}{70000}$ of its weight in water acidulated by sulphuric acid, and which surpasses in sensibility all the other re-agents for this acid.

Thus the mild nitrate of mercury is a re-agent almost as sensible for *phosphoric acid* as for muriatic acid, with the sole difference, that the precipitate by the first dissolves in an excess of phosphoric and nitric acid, whilst the precipitate by the latter is absolutely indissoluble by any acid whatever.

Intelligence

Intelligence relating to Arts, Manufactures, &c.

(Authentic Communications for this Department of our Work will be thankfully received.)

On Tanning, and the Laws relating to the Leather Trade.

THE following article is the substance of a REPORT of a Committee of the House of Commons, appointed to take into consideration an Act of James the First, concerning TANNERS, CURRIERS, SHOEMAKERS, and other Artificers occupying the cutting of LEATHER; and to report the same, with their observations and opinions thereupon. It may be considered as a more complete account of the legislative provisions respecting Tanning and the Leather Trade than has yet appeared; and it cannot be uninteresting to the manufacturer to be made acquainted with the regulations, which have been submitted to Parliament, as the basis on which a new code of laws relating to this manufacture are about to be formed, and which will probably take place in the next session.

In consequence of a number of petitions having been presented to the House of Commons from persons concerned in the manufacturing and use of leather, praying a revision of the laws on that subject, a Committee was appointed to take the same into consideration. This Committee, having examined the matter referred to them, *report*, that from the reign of Edward the Third to the time of Elizabeth various statutes had been enacted for the purpose of regulating the manufacture and sale of LEATHER, all of which were repealed by an Act of the 5th of Elizabeth, which altered and consolidated the law upon

upon those subjects. The Act of the second year of James I. which had been particularly referred to the Committee, repeals that Act of Elizabeth, together with those which had been thereby repealed, and constitutes a complete code of regulations for the internal LEATHER TRADE of this country, embracing every consideration, from the original purchase of the raw materials to the ultimate exposition of wrought wares for sale. At first it was a temporary Act, continued from sessions to sessions, until the sixteenth year of Charles I. when it was perpetuated with divers other Acts of which the term had been previously enlarged. The Committee thought that though they departed from the letter, yet that they should act in conformity with the object of their instructions, if they extended their observations to Acts of a later date, so as to give a complete view of the subject under their consideration.

They observe that in the year 1784 the Act of James I. was declared to extend to Scotland, and that it was specially declared (sess. 2. ch. 19.) that "no tanner shall exercise the trade of a currier, shoemaker, butcher, or other artificer, using or exercising the cutting or working of leather:" the Committee express their fears that by recommending the repeal of that part which prohibits the tanner from carrying on the trade of a currier and a cordwainer, they might endanger the collection of the excise duties on leather, and are therefore desirous that this point should be referred to the consideration of the Board of Excise: they are sensible, however, that the prohibition is particularly prejudicial to the Scotch tanners, who inhabit the less populous districts, where the local trade is sufficient for one person in the joint business, but not to support a tanner, a currier, and a cordwainer severally. They remark the singularity of the re-

enactment

enactment of the present reign, that no tanner should be a butcher, and point out the origin of that prohibition, which will be found in the 22d Henry VIII. ch. 6: the preamble to which sets forth, that butchers having exercised the mystery of tanners, and not being expert, have made deceivable leather; that they have bought stolen cattle, and by putting their hides suddenly into their tan-pits have prevented the owners from finding their property; and it was therefore enacted, that no butcher should be a tanner. But the Committee imagine that the special re-enactment of that clause must have been an oversight on the part of the legislature, as the grounds originally alledged are so inapplicable to the present state of the country.

With respect to the purchase of *the raw material* used in tanning, it is enacted by the statute of James, that none shall buy, contract for, or bespeak, any rough hide or calf-skin, except only such persons as shall tan or taw the same; and that no tanner shall forestall any hides, or buy them, except in open or fair market: and it is added, that no person shall buy any tanned leather but such as shall work it into wares. These regulations have been in part suspended by an Act of the first Parliament of the present year; and the Committee think that they may be repealed, as contrary to the principles of sound policy, and because no public advantage can result from the enforcement of them.

With regard to *the ingredients* used in the process, it is enacted, that no person shall buy any oaken bark with intent to sell the same again; and that oak trees to be barked shall not be felled but between the first day of April and the last day of June. The Committee observe, with respect to the last restriction, that, if the price of bark is so considerable as by its own operation to induce the

the proprietor of timber not to fell his trees at an unseasonable time, the enactment must be superfluous; and if the price be not a sufficient inducement, the demand for bark cannot be so great and urgent as to render the restriction necessary: and the tanners themselves do not conceive it to be now important. The Committee, however, state a representation made to them by the English tanners, that if the clauses which forbid engrossing and regrating oak bark were to be repealed, they should fear an increase in the price of that article, in consequence of the intervention of a middle man, who must have an intermediate profit: they also represent that speculators, with a capital of no considerable magnitude, might buy up the greater quantity of bark in any inland county, and raise the price to the tanner to an unjust and extraordinary amount; and in consequence of the general inadequacy of the supply from abroad, and the particular obstruction of the Northern parts of the Continent at this time, it would be difficult, if not impossible, for the tanner to resist the demands of such a speculator. The Committee, however, consider the clause to have been long dormant and obsolete; and, notwithstanding these objections, are of opinion, that it is contrary to the true principles of commercial regulation: they apprehend that without the intervention of such middle men to facilitate the supply of Ireland, of Scotland, and of some parts of South Britain, the tanning trade would be materially obstructed, and in some places perhaps annihilated: and they remark, that in parts of the country where the produce is abundant, and the transportation difficult, combinations have been formed, by the most opulent tanners, to reduce the proprietors of bark to their own terms, which have often proved successful; and the Committee consider that the formation of such combinations would

be

be materially facilitated, when, by the removal of antient and impolitic restrictions, the tanner shall be at liberty to make use of whatever ingredients in his own opinion may best answer the purpose to which he wishes to apply them; restrictions calculated to prevent improvement and useful discoveries, and to shackle the manufacturer without any advantage to the community.

It had been urged by the tanners in support of their petitions, and had been admitted by the artificers, who would be interested in controverting the statement if it were questionable, that leather which is not well and properly tanned cannot elude the observation of a careful examiner, and that it is not necessary, with a view to the prevention of fraud, to lay any restrictions on the tanner as to the use of whatever ingredients he may think serviceable. It had been also represented, that vitriolic acid is indispensibly necessary for the preparation of butt leather; that willow and birch bark would be valuable to the tanner, the latter of which bears a price nearly equal to that of oak bark in Ireland; that elm bark would be an excellent substitute; and that *terra Japonica*, which has been recommended by Sir Joseph Banks, contains as seven or eight to one of the tanning principle, and tans leather in every respect as well as oak bark, except the unimportant one of colour; and yet the use of all these ingredients is forbidden by the Act of James the First. It had likewise been stated to the Committee, that the American bark, called *quercitron*, which is imported on account of other qualities for the use of dyers, contains but as three to five of the tanning principle compared with English oak bark, but that a sample of a different American bark, which did not answer the purpose of the dyers, was tried by Mr. Williams, a tanner at Greenwich, and found to contain a greater proportion than Eng-

lish oak bark: it appeared, therefore, to the Committee to be a valuable article for importation.

The Committee next report their having been assured that leather cannot be made dry at all seasons of the year by the means which are allowed, and that the careful use of fire or summer sun would not be prejudicial to its durability, and that any injury which it might receive from neglect would be evident to the most unskilful purchaser: and that, although the Act directs that not less than a year shall be employed in tanning sole-leather, and nine months in tanning upper-leather, the time actually necessary for tanning sole-leather varies according to the season of the year, and the thickness of the hide, from fifteen months to seven, and for tanning upper-leather from six months to six weeks, the process being quickest in the summer; and that if the length of the tanning process, which the Act directs, was to be observed in all cases, some kinds of leather and some parts of the hide would be injured, and rendered almost useless. And they express much satisfaction that no material difference of opinion exists among the petitioners on all restrictions which are not conducive to the security of the public, or of any individuals; but they add, that their attention has been directed to another important part of the Act of James, concerning which there exists much difference of interest and opinion.

The Act directs that the Lord Mayor and Court of Aldermen of the City of London, and other Mayors, &c. within their respective jurisdictions shall appoint searchers and sealers of leather, by whom all leather shall be searched and sealed before it be sold; and that they shall seize all leather not properly tanned and dried, and that all leather must be registered in the market; and certain dues are payable thereon to the searchers. The Committee observe,

observe, that these regulations are indeed become obsolete in most parts of the country, except Bristol and a few other places, and that the practice of confiscation is not resorted to, except in Leadenhall Market, where it has been enforced since about the year 1790; and they notice many abuses and improper customs which prevail in that place, both on the part of the City and of the searchers themselves: but, though these and other abuses have occurred in the execution of the statute, they did not confine themselves to this point only, but conceived that the law itself, the principle and grounds on which it is founded, required their most anxious investigation. A plea was, however, set up in bar of this investigation by a petition of the City, alledging that the appointment of searchers and sealers was a right which they claimed by prescription, and with which it would not be proper for Parliament to interfere. This allegation was supported by extracts from the books and records of the city, shewing that these appointments were made as early as the third year of Henry the Seventh; but the Committee held that in the cases adduced the City acted under the direct injunctions of a statute of Henry the Fourth, which was first ordered to be put in assay for a year, which was afterwards continued, and at length repealed by the Acts of Elizabeth and James.

The Committee therefore imagined that they might proceed to decide upon the propriety of such regulations without any fear of trenching upon the priviſeges of the City of London. They weighed with minute attention the evidence which had been brought forward by the contending parties; and they adopted as a principle to guide their determination, that all penalties and restrictions in the mode of selling any article, if unnecessary, are unjust and vexatious; that they can only be

necessary where, from the nature of the traffic, there is an evident danger of fraudulent dealings according to the natural course of the market; and that where fraud is apprehended, and regulations are deemed indispensible, they ought at least to be constructed on the most even and equitable foundation. In their opinion the subject divided itself into two questions: the one relating to the sufficient tanning, the other to the sufficient drying of leather. The first appeared to affect the ultimate consumer, and not the intermediate artificers: the second was of no importance to the public at large (excepting inasmuch as it may be the interest of all individuals that the intermediate artificers shall not be defrauded), but tended simply to affect the security of the artificer as to his bargain in the market. The artificer must have competent skill to ascertain whether leather is or is not sufficiently tanned; it was stated in evidence that he could not in that respect be deceived; the price of the leather will vary accordingly, and he incurs no risk of being mistaken as to the nature of his bargain: but when the leather has passed through the hands of the artificer, and is wrought into wares, the unskilful consumer is liable to fraud; the article if under-tanned will be specious and little durable; the purchaser of ready-made wares will be the sufferer, and the character of the Export Trade may be prejudiced by fraudulent adventurers; an evil which, if it should once occur, could not possibly be remedied till the confidence of foreign nations should have gradually revived. With respect to the dryness of leather in the market, it is of no importance to the consumer: the artificer is for the most part under the necessity of moistening it again: the intermediate purchaser alone is interested, who buys at a certain rate *per* pound an article which is liable to imbibe moisture, and to increase or diminish in weight according to the state of the surrounding

rounding atmosphere, and on that account the curriers and cordwainers are most anxious to oppose the repeal of those penalties and restrictions which protect them from the risk attending on such variations, and render it less necessary for them to examine with nice accuracy the goods at the time of purchase. It was admitted by the tanners that a purchaser cannot generally ascertain within less than two *per cent.* what extraneous weight leather may have received from moisture; it was admitted, that leather packed in a wet condition would be liable to injury; it was admitted, that since the frequency of seizures and confiscations the average loss upon the market-weight has diminished. It was admitted by the curriers and cordwainers, that the purchaser has the same opportunity of examining the leather as the searchers; that it is placed in the same situation in the market when exposed for sale, and when exposed for the examination of the searchers; that the purchasers are generally better judges than the searchers; and that he must be very unskilful who would pack leather in a wet condition. It was asserted by the tanners, and admitted by some of the curriers, that leather cannot be made apparently dry without being actually so, and that the purchasers seldom rely altogether on the seal of the searcher; but it was farther represented, that before the enforcement of the Act, it frequently happened that the currier could procure no dry leather in the market, and that though he would have given a higher price for dry leather, that consideration did not operate sufficiently to induce the tanner to bring it dry to market, while he could derive a countervailing advantage from the increased weight in consequence of neglect; and that the currier who is forced to purchase wet leather, cannot procure in town the same accommodations for drying it which the tanner possesses in the country.

It

It appeared therefore to the Committee, upon full consideration of the evidence, that certain regulations might be adopted which would secure the artificer from all the danger which he apprehends, without subjecting the tanner to the vexatious inquisition of a needy and interested informer; to the loss of credit and immediate remittances, by the seizure and detention of his goods; and to a penalty so enormous as total confiscation: and, with a view to the repeal of the existing law, they have laboured to frame such regulations as they conceive will prove effective, without being open to the same objections.

They have farther considered, that the clauses which direct in what manner leather shall be curried, and in what manner wares shall be wrought of leather, are vexatious and absurd. The consumer is not liable to imposition in that respect, and the interest of the artificer, who must understand the mystery of his own craft better than the legislature, is the best security to the public. They, however, conceive it adviseable, for the purpose of upholding the reputation of our Export Trade, to continue a penalty upon leather insufficiently tanned, and perhaps upon boots and shoes made of sheep-skin, which are deceitful articles, and not easily distinguishable by the purchaser; but a periodical search of the premises of the currier and cordwainer, for the purpose of seizure and confiscation, as enjoined by the Act of James, must be either nugatory, or extremely irksome and oppressive.

The Committee having stated their observations as far as they deemed necessary, and having fully considered the Act, and the petitions referred to them, concurred in the following Resolutions.

1. Resolved, That it is the opinion of this Committee, that the said Act ought to be repealed, and that other regulations ought to be adopted, which will effectually secure the purchasers of leather, without being oppressive

sive to the manufacturers; and they have annexed to their report the substance of such regulations as they have thought it their duty to suggest.

2. Resolved, That it is the opinion of this Committee, that the fourth section of the 13th and 14th Charles II. ch. 7, which directs that all leather shall be brought to market to be searched and sealed, ought to be repealed.

3. Resolved, That it is the opinion of this Committee, that the 13th section of the same Act, which directs that every artificer buying red tanned leather in or near London, shall give notice thereof to one or more of the Company of Curriers, and deliver up the same within a certain time, to be curried according to the directions of the Act of James, ought to be repealed.

4. Resolved, That it is the opinion of this Committee, that the fourteenth section of the same Act, which directs that the Master and Wardens of the Company of Curriers, or persons appointed by them, shall search the premises of the cordwainers, ought to be repealed.

5. Resolved, That it is the opinion of this Committee, that the tenth section of the 9th Anne, ch. 11, which re-enacts the greater part of the said Act of James, ought to be repealed.

6. Resolved, That it is the opinion of this Committee, that the 24th Geo. III. Session 2, ch. 19, which declares that so much of the Act of James which is recited in the 9th of Anne, extends to every part of Great Britain, and specially declares that no tanner shall exercise the trade of a currier, shoemaker, butcher, or other artificer occupying the cutting or working of leather, ought to be repealed; excepting so much thereof as forbids a tanner from exercising the trade of a shoemaker, or other artificer occupying the cutting or working of leather; which the Committee recommend the House to refer to the consideration of the Board of Excise.

7. Re-

7. Resolved, That it is the opinion of this Committee, that the Chairman be directed to move the House, that leave be given to bring in a bill concerning tanners, curriers, shoe-makers, and other artificers occupying the cutting of leather; for the removal of certain penalties and restrictions, and for the better regulations of the sale of leather.

The Regulations suggested by the Committee as the basis of future Laws respecting the Leather Trade will be inserted in our next Number.

List of Patents for Inventions, &c.

(Continued from Vol. XI. Page 464.)

JOHN DICKINSON, of the parish of St. Martin Ludgate, in the city of London, Stationer; for making common cartridge paper, manufactured on an improved principle. Dated Nov. 12, 1807.

JOSEPH JEWELL, of Stratford, in the county of Essex, Chemist; for a method of preparing or reducing to an impalpable powder, for medicinal use, the substance commonly called or known by the name of Colomel, whereby the process usually employed of levigating the same is rendered unnecessary. Dated Nov. 17, 1807.

WILLIAM LESTER, of Paddington Green, in the parish of Paddington, in the county of Middlesex, Engineer; for various farther improvements on an engine or machine for separating corn, seeds, and pulse from the straw and chaff, and for which said engine or machine the said William Lester obtained his Majesty's letters patent, dated January 16, 1805. Dated Nov. 21, 1807.

SAMUEL ROBERTS, of Sheffield, in the county of York, Silver Plater; for a toast-tray, capable of being contracted or expanded at pleasure. Dated Nov. 28, 1807.

THE

REPERTORY

OF

ARTS, MANUFACTURES,

AND

AGRICULTURE.

No. LXVIII. SECOND SERIES. Jan. 1808.

Specification of the Patent granted to WILLIAM CHAPMAN, *of the Town and County of the Town of Newcastle-upon-Tyne, Civil Engineer, and* EDWARD WALTON CHAPMAN, *of the same Place, Rope-maker; for a Method or Methods of making a Belt or flat Band for the Purpose of drawing Coals or other Minerals up the Pits or Shafts of Mines, and for raising of heavy Articles in any Situation whatever.* Dated October 30, 1807.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, we the said William Chapman and Edward Walton Chapman do hereby describe and ascertain the nature of our said invention to be as follows; namely: First, in the combination of two or any greater number of strands of shroud-laid rope laid side by side, so as to form any determinate breadth of belt or flat band; and secondly in the peculiar machinery for facilitating its formation. A strand of a shroud-laid rope is the first combination of the

yarns, which are twisted together round one common axis, so as to form a compact cylindric mass; and the common shroud-laid rope is formed of three of these strands twisted together the contrary way to the twist of the strand; which for common purposes is necessary, although the loss of strength is so considerable, that exclusive of the reduction of length from being made into a rope, the strength of two strands made in such a way as to make all the yarns bear an equal tension, or nearly so, will, when laid side by side, be nearly equal to that of three such strands combined in a rope; from which circumstance the chief advantage arises in forming the strands into belts, instead of making them into ropes.

Having explained the advantage the public may derive from the use of these belts, we now proceed to shew what appears to be the best method of putting them together, and then to describe the machinery we have invented for that purpose. The belts will be best composed of an equal number of strands, each alternate one twisted the contrary way to the other, so as to counteract the tendency they would otherwise have to twist round one another. It is also eligible that the yarns for the differently twisted strands should be twisted contrary ways. Four, six, or eight strands will form the most convenient belt, but each extreme verges towards its respective disadvantage: *viz.* if liable to be chafed, the broad belt will be soonest injured; but, on the other hand, the narrow belts, from the necessarily increased thickness of the strands, will sooner destroy themselves by bending over the pulleys.

In forming the flat belts, attention should be paid to the strands being all brought to an equal tension before they are combined together, which combination may be done in any manner at the pleasure of the manufacturer.

They

They may be riveted together at proper intervals with strong iron wires, or laced or stitched together. The easiest way of stitching them is, whilst they are laid at length in the rope-ground, to attach each strand to a rope, on which, by means of leading pulleys, equal loads or weights may be suspended, which will stretch each strand equally. If these weights descend to the ground, they may be raised by heaving at the opposite end of the proposed belt. Means of course must be taken to prevent the strands untwisting, which may easily be done by fastening a sufficient weight below each where they are attached to the stretching ropes, so as to prevent their turning round. The degree of tension upon each strand should be proportionate to what the whole belt has to bear. The remaining process is to combine the strands side by side, which, as before observed, may be done in any manner at the pleasure of the operator: we shall, however, describe a method of doing it: *viz.*

By having a sledge or four-wheel truck resting under the strands with a frame at or a little above their level, on each side of which is affixed a screw *a a*, Fig. 3, (Plate IV.) hollow within, so as to receive the shank of a large needle with an eye near the point, as in some needles used for packing bales. Each of these screws may point rather obliquely across the strands which are to compose the belt, and be kept in its due direction by two standards or bars *c c*, Fig. 3, with cylindrical holes, through which the screw passes, leaving a space between the bars to receive a nut or concave screw *m*, Fig. 3, with arms, through which the screw will likewise pass. In the screw there must be a groove parallel to its axis, to receive a feather or thin piece of steel, fixed in a longitudinal groove in one or both of the cylindric holes *c c*, through which the screw passes, so that, on

turning the nut *m*, it shall push forward or draw back the needle. Fig. 3 shews the truck with its screws and needles: the size of the latter may be enlarged or reduced at pleasure to suit belts of any size; but the screws and truck will be common to all, by means of what we shall call a belt board; see *n n*, Figs. 1, 2, and 3.

The belt board is formed of elm or any suitable wood or other substance; in the middle of it there must be a groove of suitable width to admit the designed number of strands or lines to lie side by side, and of any suitable depth to retain them in their places. Also the thickness of the bottom of each belt board may be such as to raise the centre of the strands to a level with the needle; or, to save the necessity of numerous belt boards, one side may be made to approach to or recede from the other by means of screws; and when placed upon the truck for the use of any belt, this board must be adjusted by wedges or screws to such level, as that the centre of the strands or lines shall lie fair to the direction of the needles; also the bottom of the belt board opposite the side opening should be hollowed, sufficiently to admit the swelling of the strands on the passing through of the needle. It is obvious, that the strands or lines should be kept firm down in their places, which in general will be sufficiently done by the level of the belt board being rather higher than the direction they are stretched in, as shewn in Fig. 2; but should this not be deemed sufficient, they may be pressed down in the groove by weights fitting it, or by rollers at each end. The strands or lines being stretched as described, one, or any suitable number of these trucks with their apparatus may be placed under them, so as to expedite their being stitched together; the process of which is as follows; *viz.* A suitable thong, thread, or line, of length sufficient to make any convenient

nient number of stitches, has a knot or other fastening at one end, and the other is put through the eye of one of the needles, which is then, by turning the nut, pushed through all the strands or lines. It will be eligible to have the end tapered which goes through the needle. On drawing the end from the eye of the needle, the latter is drawn out of the belt by turning the nut the contrary way, and then the thread or line is drawn tight, and the truck is brought forward, so as to bring the point of the other needle to the proper position for making the next perforation, which, after inserting the end of the thread, is done as the preceding; and in this manner the operation goes forward until the thread be exhausted. The end is then either fastened to the next thread, or secured in any convenient way, and the operation is continued to the completion of the belt. Or the stitching may be performed by first pushing the needle through the strands or lines, and then putting the thread through the eye, and hauling it through on the withdrawing of the needle, in which case the direction of the needles must be towards the tail or receding end of the truck. The connecting of strands side by side by interlacing, is so obvious as to need no description. If the riveting of them by strong wire or rivet pin be deemed eligible, the pins may be forced through by having two side screws, similar to those described, placed upon the truck directly opposite to each other, and pointing in the same line. One of these screws may have a cylindric piece of steel with a sharp point, by which a hole may be made through the belt; and the end of the other should have a socket, into which the head of the rivet pin may be inserted. The pin may be about the eighth of an inch in diameter, and on entering the point in the hole made by the instrument from the other side, the rivet pin may be pushed through, and the truck

truck brought forward to the proper position for the next, which may be at a space equal to the width of the belt, after which, and putting on the rivet or burr, the pin may be riveted over it. To prevent the head and rivet of the pin from injuring the strands or lines they attach together, little pieces of leather with holes through them may be used; one piece slipped over before the pin is put through, and the other put on before the rivet. The screws on each side of the sledge need not be made as already described, as they will be better for revolving round their axis; therefore, in place of passing through cylindric holes or guides, they must go through correspondent hollow screws, and have handles or fliers at their outer ends, by turning of which they will be drawn backwards or forwards, as wanted.

Also the screw before described for pushing through the needle, need not indispensably be prevented from turning round by means of a longitudinal groove and feather, as the same end may be answered by making an extension to one end of the screw of any form which will not turn round; but let it slide backwards and forwards through a suitable groove. Likewise, in place of needles, piercers may be used, and the tapered ends of the stitching lines be put through. In the use of the belts for raising weights of any kind, it will be most adviseable for the belt to be confined to roll upon itself as a spiral; but in some cases this may be dispensed with. The hauling forward of the truck any determinate space between each stitch, may be done by means of a winding barrel on the sledge, and a chain or rope leading from it to any fixed object, and in a variety of ways so obvious as to require no description, although the progressive transition of the machine from place to place is one of its most essential constituent parts; because without this moveability it could

Fig. 1.

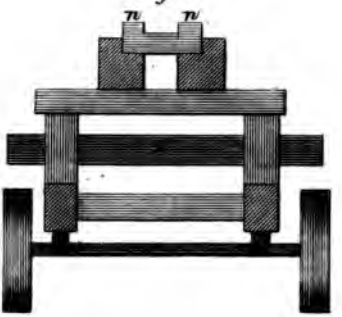


Fig. 2.

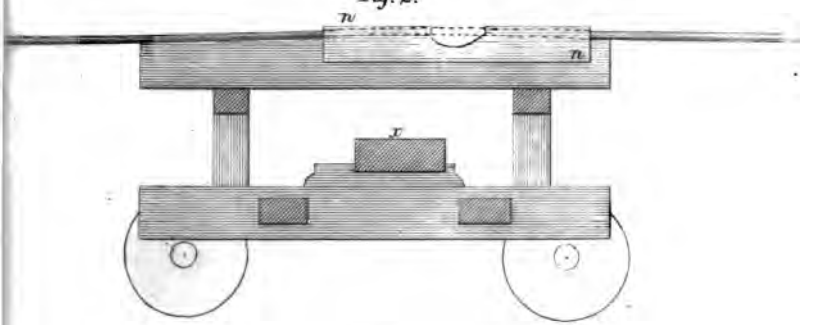
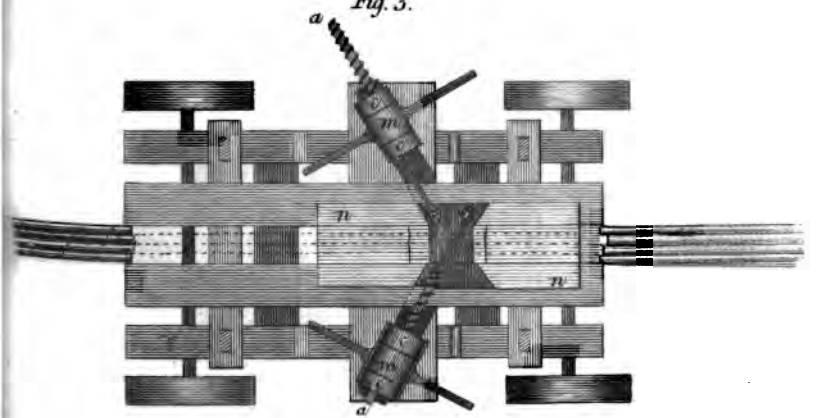


Fig. 3.



could not be applied to the stitching of any belt, where its parts to be thus connected are lying stretched at length side by side. But if the operator prefer drawing forward the belt or flat band as it is stitched, then the truck or frame may be stationary and without wheels. All that this invention consists of is the use of strands laid side by side, so as to acquire a strength which ropes used in this manner would not have; and also, the invention of the truck or frame with its apparatus, for combining speedily and correctly together any requisite number of strands or other flexible substances laid side by side.

In witness whereof, &c.

Specification of the Patent granted to OBADIAH ELLIOTT, *of the Parish of Saint Mary Lambeth, in the County of Surrey, Coachmaker; for certain Improvements in the Construction of Coaches, Chariots, Baroush, Landaus, and various other Four Wheel Carriages.*

Dated May 11, 1805.

With a Plate.

TO all to whom these presents shall come, &c. Now KNOW YE, that in compliance with the said proviso, I the said Obadiah Elliott do hereby declare, that my said invention, which consists in the constructing or making coaches or any four-wheel carriages without a perch or cranes, is described and ascertained by the above drawings and the following description thereof; that is to say: Fig. 1. (Plate V.) A A are the fore and hind springs which are fastened together by two circular loops B B, and are fixed or otherwise fastened to two beds which project from the body or boot; and two pieces of timber

timber are framed before, and two pieces when required behind, from the front and hind seat rail, which project out at each end of the body to receive the spring bed or beds. Fig. 2 is the principle of Fig. 1, applied to a chariot. Fig. 3 represents the top horizontal wheel fixed to the body or boot for the purpose of locking round. Fig. 4, C, the top front springs fixed to the bed, which projects from the horizontal wheel E, F the spindle bar, as fixed with nunters or futchels framed into the bed D; the hind springs are fixed with a projection from the body the same as the front, but without the horizontal wheel, see A A, B B, Fig. 1. Fig. 5, F F, shew the ground plan of the mode of fixing the bottom springs on blocks on the front and hind axle-tree. Fig. 6 is a side view of the springs A A, Fig. 1, with coupling plates B B, and blocks with oval or other shaped holes in the bottom spring, to prevent the coupling plates B running round; B a coupling plate by itself. Fig. 7, the fore springs and horizontal wheel the same as Fig. 1. G is an iron loop or socket projecting down from the bottom of the body under the door to receive the end of the spring H, which reaches to the hind axle-tree, and fastens on a block with clips or bolts. I, a cross spring bolted or otherwise fastened on the bottom of the body, fixed across or underneath the spring H, by a loop or loops, sheckles or braces, to give it side play or swing if required. Fig. 8 *a*, a ground plan of the hind axle-tree and springs of Fig. 7; I, the cross spring; G G, the loops shewn both ways that fasten the four ends of the springs to the body; see H, Fig. 7. Fig. 8 *b*, a ground plan of the hind axle-tree and springs of Fig. 9, and the same as Fig. 7. G G, two views of the loops. Fig. 9, K, the two side springs fixed to the fore axle-tree on blocks with clips or bolts; L L, two cross springs fastened to the bottom of the nunters or futchels

Fig. 1.

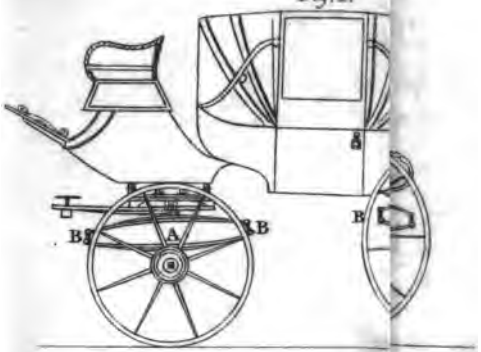


Fig. 3.

Fig. 4.

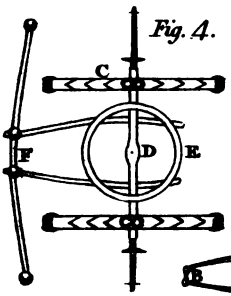
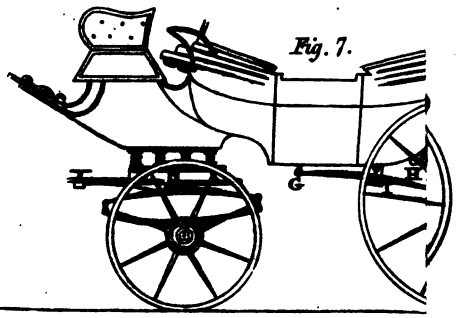


Fig. 6.

Fig. 7.



futchels with clips or bolts; the nunter or futchels are framed into a bed fixed to the bottom of the horizontal wheel, as seen in ground plan Fig. 10. The hind part is hung or suspended on the principle of the hind part of Fig. 7. Fig. 10, the ground plan of the fore part of Fig. 9; K K, the two side springs fixed on axle-tree; L L, the cross springs bolted on the bottom of the nunter or futchels, with or without blocks, as most convenient. I use springs either with or without braces, as may best suit the intended purpose; and I also vary the size, shape or form, and the application of such springs according to existing circumstances, or as different roads may require; and if required, I also fix a brace or braces, rope or ropes, chain or chains, from any convenient part or parts of one axle-tree to the other, and from the fore axle-tree to the splinter-bar. In witness whereof, &c.

Specification of the Patent granted to ELIZABETH BELL, *of Blackheath, in the County of Kent, Spinster; for certain Improvements in an artificial Method of Sweeping Chimnies, and an Improvement in the preparing and manufacturing Pieces used for constructing the Chimneis, so as to render the said Pieces capable of being better joined together, and more advantageously used for conveying Smoke, Water, and other Fluids or Bodies in a divided or pulverulent State in any required Direction, and for certain Methods, Machinery and Apparatus, useful or necessary for manufacturing such Pieces, and applicable for the Purpose of forming various other Articles of Pottery.* Dated March 7, 1807.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said Elizabeth Bell, in compliance with the said proviso, do hereby declare that my

said invention is particularly ascertained and described in and by the description hereunto annexed.

In witness whereof, &c.

Improvement in Article No. 1 *of the Specification of my former Patent, dated May* 10, 1803 *.

No. 1. The apparatus at the top of the chimney may be made according to the manner described in the specification of my former patent, dated May 10, 1803, and may be used with considerable advantage; but the improved method will be found to be more efficacious. It consists of a frame of iron or other materials composed of two semicircles, which should possess a considerable degree of adjustment by means of screws, so as to encompass and adapt themselves to all the various sizes of chimney-pots that are now in use. To these semicircles are attached upright bars, and at the top of these are fixed cross bars with a couple of supports, which cross bars contain the friction roller, over which the chain, rope or line, may be made to pass, while it is performing its passage of ascent and descent in the act of cleansing.

This apparatus not only enables a person to sweep any chimney from the bottom, but always provides a ready method of keeping the chain, line or rope, in a situation that the chimney may be cleansed at a moment's warning. The having a chain thus suspended in a chimney will be found to produce a considerable benefit, as it will operate as a convenient means to the apparatus hereinafter described for extinguishing fire in the chimney, *(which)* may be instantly attached to it.

Improvement in the Article No. 2. *of the former Specification.*

No. 2. My lever brush, as described in the former specification, may be used in some chimnies; but it will be

* Inserted in vol. IV. of the present series.

found

found in general more useful in its operations when made according to the following improved manner. I make it in its general principle the same as before, except by making the body or main piece circular instead of square, and inserting the ends of the levers in the body or main piece, in order to prevent their catching on the seams of the brickwork on the levers. I now make to each a pair of recurved springs acting against each other; and the point of junction is let into and attached to the main piece by means of a pin or pivot, at the same time so free and loose as to permit the springs to move at their point of junction in any required direction; these springs at their lowest extremity are furnished with a case or bed to receive the shaft of the lever, and the lever above the part furnished with brushes, prevented from receding from it by a pin; the upper extremity of the lever is let into the block, body or main piece, by a knee or double joint, capable of permitting it to have such a motion as to act freely in every required direction, which action is regulated by the springs, so as to make it expand and contract according as it is pressed upon by the sides of the chimney in its ascent and descent; and the middle lever is moved outwards by a circular spring acting from the centre to that part of the lever above the brush. The action of the lever is likewise regulated by cords or chains passing through the lever nearest to the extremity, where the brushes are placed for the purpose of cleansing the chimney; the cords pass from thence, and are united in one point of junction through an eye and friction roller. The means of regulating them are described in my former specification; instead of the tube being as before made of a length sufficient to sweep the pot on the top of the chimney, I have constructed a small circular brush with a perforation to permit the chain to pass through it, in

order to ascend before any of the sweeping brushes, for the purpose of cleansing the pot on the top of the chimney; and I sometimes make a small brush of the figure and dimensions necessary to cleanse the pot, and this small brush ought to pass up before the rest; and I farther improve this by giving the pipe or tube a flanched socket, which will be capable of receiving any of the rods commonly in use, whereby the brush may be put up the chimney, and these flanched sockets may be made either to receive plain or screwed rods, whichever may be most convenient.

Improvement in Article No. 3 of my former Specification, called my Elastic Sweeper.

No. 3. My elastic egg-shaped sweeper, as described in my former specification, will be found adapted for the generality of flues; but, in those flues whose figures are considerably oblong, it is obvious that a sweeper which assumes a circular or elliptic figure will not extend itself to all the parts of such a flue. I have therefore provided and recommend the improvement and alteration I have now made in the exterior figure of this brush, in order to render it capable of assimilating itself to the figure of the various flues intended to be cleansed; for which purpose the sweeper, in its exterior form, must be either a square or a parallelogram, whichever may be found most suitable; and instead of the springs formerly described, I generally give it the internal elastic motion by springs of the curvature and figure assimilating with its external figure and with the limbs of the brush, and to those springs I attach rollers working in a frame or groove fixed on the pipe or tube that is in the middle of the brush; and to the said pipe or tube I add a flanched socket, which will be capable of receiving any of the rods commonly

monly in use, whereby the brush may be put up the chimney; and these flanched sockets may be made either to receive plain or screwed rods, whichever may be found most convenient when the operation is to be performed by rods instead of chains; but, when chains are to be used, each of the limbs of the elastic brush is furnished with a small chain, attached to a small circle which encompasses the chain that pulls up, and this small circle is moved upon two, three, or more small pillars that proceed from the fulcrum, with power of running up and down those pillars to draw in or let out the limbs of the brush, which circle can be pulled by one chain or rope from the bottom: this I call my regulating chain, which descending to the opening at the bottom of the flue, may be worked by the crane as hereafter described. The purpose of this rope is to prevent the possibility of the brush catching on the bricks in its descent.

Improvement in Article No. 4 of the former Specification.

No. 4. The apparatus at the bottom of the chimney consists of a frame of wood made to fit the front or opening of the chimney; and in order that it may fit all chimnies, I make it in two, three, or more divisions, which are attached to each other by means of leather or flexible hinges folded in the manner of bellows, to render it capable of expanding and contracting, so as to fit the various sizes of the openings of chimnies; and I make this frame or screen not only to cover the opening of the chimney, but it likewise passes over and covers the hearth and grate, and is all united by means of the aforesaid leather or flexible hinges; it is intended to receive the soot which falls during the operation of sweeping, and which may be carried out of the apartment in this frame without causing any dust to come into the room,

so

so that the chimney may be swept without much injury to the chamber. The frame is held fast either by an upright holding within the breast of the chimney, or by a screw. A common screen or curtain may be used in houses of an inferior kind.

The apparatus attached to this, as described in my former specification, for producing the ascent and descent of my sweeper worked by chains, ropes or lines, may be used with considerable effect; but the mode which I have now adopted is much more advantageous in every point of view, which is by means of a portable crane made of iron or other sufficiently strong materials. This crane may have such a train of cog wheels as the power and velocity of its performance requires; to this crane there is a double roller or drum, one of which rollers or drums produces the ascent in the chimney, and the other the descent. This crane so constructed will enable a child to sweep and cleanse the longest chimney with considerable ease. The crane may be used on the outside of the frame or curtain placed on the hearth or any part of the chamber without soiling the apartment in the smallest degree, as the chains in their passage through the frame or curtain are completely cleansed of every particle of soot, by means of brushes and sponge which are attached to the inside of the frame at that part where the chain comes out, and passes over a friction roller in its way to the crane. The frame is to have a small shutter to slide open, that the operator may take the sweeper from the chain when the chimney has been cleansed.

Improvement in Article No. 5 in the former Specification; Sweeping Apparatus.

No. 5. The method described in my former specification may be used, but I have now improved it by making

ing the frame with a power of altering its figure by means of screws, so as to adapt itself to the various forms of chimnies.

Improvement in Article No. 6 of my former Specification; Cylinder Brush.

No. 6. The cylinder brush as described in the former specification may be used, but in its present improved state it will be found in most cases more suitable; I now construct it by dividing it longitudinally into two, three, or more pieces, by means of hinges of iron, leather, or other convenient material; and I sometimes divide it in an horizontal direction, so as to make it by those divisions pass easily over the angles of the flue.

This brush is intended for the purpose, more especially, of cleansing circular chimnies.

No. 7. *Rotary Sweeper as described in my Specification, dated May 10, 1803, and now improved.*

This brush or brushes is as follows: I give it or them a rotary motion the same as before, at the same time that it is performing its ascent or descent in the chimney; and this rotary motion I produce either from the top or the bottom of the chimney, by any of the means by which rotative motion can be produced. A brush possessing these powers will be found particularly advantageous in small flues, as it is well known that such a motion given to a body of a figure which is capable of extending its limbs in an horizontal direction, derives the full power of centrifugal force, which will cause all loose matter or bodies to fly off, without any part of the discharging machine or brush coming into such contact with the chimney as to prevent ascent or descent; and the brush which I employ for this purpose, is of a figure nearly resembling my egg-shaped elastic sweeper, but of smaller dimensions; and the limbs

or

or pieces joined loosely together by means of leather or cloth, or other flexible substance, and without springs in the internal part.

Improvement in the Apparatus for extinguishing Fire as described in my former Specification may be used; but I recommend in most Cases the following Improvement.

The exterior figure may be either square, circular, or parallelogram, or oval, or of such figure as most easily to suit the flue of the buildings where it is to be used; and in order that it may be capable of altering its figure, I make it of ribs or staves of metal, or incombustible materials, so placed as to be capable of contracting and expanding, and of such size and form as never completely to separate from each other; and this vessel so formed, I furnish with a lining of leather or skin, or any substance capable of containing water, and flexible, which lining must be completely guarded by the exterior metal figure, and the lining and metal covering must be furnished with a valve, shutter or slide, to be operated upon by a spring or check; in all other respects it is similar to the specification of my former invention. The blocks for circular chimnies I make according to the manner described in my former specification, except that I have improved them by sometimes making the circle in the middle beveled, so as to accord with the intended curvature or angle of the flue, instead of perpendicular as formerly; at the same time that the exterior preserves its perpendicular and square form.

And I farther improve the blocks by making them of such a form as may render them capable of being put to a certain height in the chimnies which have already been built of a square form. In which case I make their exterior form of a circular figure, with beveled or sloping joints and overlapings, so formed that with the aid of cement

cement, no air or smoke can penetrate through them; and I sometimes make them with knees or slopings, to assimilate with the bevel of the flues of such chimnies.

And the said circular blocks may be not only used for the purpose of conveying smoke, but also of conveying all sorts of fluids or bodies in a pulverulent state; and in order to render them generally useful, and in all situations fit for conveyance of water or other fluids, and that they may be incapable of injuring the water or fluids, I give the internal part a certain degree of vitrification by means of any of the substances best capable of producing a powerful and firm vitrification, and, likewise, in order to protect them from external injury, and to add to the strength of the pipes or blocks meant for the conveyance of fluids.

I take them after they are burnt and sufficiently cold, and wash them with a strong cement, and instantly roll them in the ferruginous clay or any other strong clay, either mixed or otherwise, to an inch or more thick, and let them harden in the sun, and then wash them again in the cement; but when they are intended for inferior purposes, the expense of the covering of clay and cement may be omitted.

Having found during the progress of my making my pipes or blocks, the manufacture greatly retarded by the method generally used by potters, I now find it absolutely necessary to employ the following mechanical means; that is to say: I form and manufacture the blocks by means of troughs or moulds of the exact dimensions requisite for the different kinds of blocks, either those for the upright shaft of the flue, or for the beveled parts of it. On the bottom of these troughs or moulds I place sliders or carrying boards, furnished with the requisite mouldings and fittings to form the joints of one side of

the blocks; and having so placed those moulded carrying boards, I fill the troughs or moulds with the clay or other material of which the blocks are to be made; and after the trough is filled and pressed, and streaked and smoothed off with a streaker or other fit and convenient instrument, I cover it over with a lid, shutter, or other convenience, fitted with mouldings, to form the joints of the other side of the blocks; the said lid having circular openings placed at due distances, to admit of an instrument to pass through for the purpose of perforating the blocks in a circular or other figure, and of the diameter necessary to form the required internal perforation of the blocks. The clay or admixture so inclosed is introduced between a pair of rollers of sufficient strength and capability for not only pressing, but for forming such minute impressions as may be requisite to the formation of clay in any shape; this method of working clay will produce great exactness in the most minute parts, and such a degree of solidity as will in a great measure prevent the earthen-ware from cracking in the drying. The clay being thus pressed and prepared for perforation, will be found to be more easily and safely perforated than in any other stage in which clay can be operated on, more especially when it is perforated by means of a borer in the form of a pipe or tube, which I generally place in any required angle, so as to give the apertures in the blocks any required directions. This mode of boring will not only be more expeditious, but much more accurate than is capable of being done by any drill in use.

Second Method of making the Blocks.

I sometimes make my circular blocks or pipes by means of inclosing the clay (after it is duly prepared) of which they are to be made or formed, into a tube, cylin-

der,

der, or barrel, or mould which takes asunder by joints, pins or hinges, or other convenient means. The interior figure of this said tube, or cylinder, or barrel, must accord with the exterior form of my blocks or pipes; and the clay so inclosed I bore, perforate or pierce by means of a piercer, whose length is twice that of the pipe or block. One half of the said length is taper, the other cylindrical, and whose greatest diameter is equal to the full diameter of the aperture of the pipes or blocks. And the one end of the cylindrical points of the piercer or borer must be of such a figure as to produce the required joint of the block of pipe as to make them fit to and exactly join into one another; and this piercer I introduce in a centrical position into the mould which contains the clay to be pierced, and is kept in order by a gauge, and by means of a pile-engine or common ram-screw, or other forcing power. I drive the piercer through the whole length of the inclosed clay in the mould; and the clay which the piercer discharges I allow to pass through a hole at the bottom of the mould; and when the whole of the taper-part of the piercer shall have arrived completely through the pierced block or formed pipe, then I give a rotary motion to the piercer, which not only makes a smooth surface in the interior of the pipe, but renders it very solid and firm, and gives a readiness and facility to the drawing of the piercer. This mode of making my pipes or perforated blocks will be found to be not only the most expeditious but the most perfect, as pipes or blocks so made will not be liable to crack, as is so frequently the case in all articles of pottery of a long perforated figure.

Or the before-mentioned piercer may have a brass wire passed down the whole length of the cylinder, and the wire confined in a double ring, which ring passes

round the cylinder; the wire by this means is drawn round the cylinder for the purpose of cutting off the clay from the piercer.

Likewise I have found great delay and expense incurred by the usual method of grinding the clay; and that the stones and other extraneous matter not being separated from the clay, causes great loss by the articles breaking in the burning owing to stones left in the clay. I therefore make the apparatus for grinding and mixing the clay as follows: I make a trough, tub or cylinder of iron, or other sufficiently strong material, of a circular, or oblong or square figure, open at the top, and of such dimensions as may best suit to hold the quantity of clay required to be ground, and the inside of this trough, tub, or cylinder, is furnished with knives or cutters, placed at different angles; which knives project three or four or more inches from the sides of the said trough, tub, or cylinder; and in its centre is stationed a pillar or spindle of iron, or other strong material, upon which I place six, eight, or more knives or cutters, placed at different angles, and which shall, in one revolution of the pillar or spindle, operate upon the whole of the clay that may be contained in the trough; and the knives thus placed on the pillar or spindle must have their position such as shall permit their passing easily between the spaces, distance, or opening, left between the knives or cutters aforesaid that are fastened on the inside of the trough: that is to say; the spindle, in its revolution round its own axis, causes these knives and cutters to pass between the knives that are fixed on the inside of the trough so placed as to act in a transverse direction. I place the knives at such distance from each other as to leave room for the clay to pass the spindle or pillar, which I make to revolve in the interior of the trough. And there is a shaft of iron passed through

through the pillar or spindle, and this shaft rises and falls; by which means four or more iron or other rollers that are fixed to it, are made to revolve in their respective orbits, and act as breakers of the clay by their gravity and motion, and instead of the spindle, pillar or main mover, the mill being operated upon in the usual manner of a lever, bearing on the horse's neck. And I attach to it a lever and balance, or, in some cases, I place on the top of the spindle or pillar one, two, or more notched wheels placed in a horizontal direction, and one wheel attached to the internal shaft, and the other to the spindle or pillar; and those notched wheels are acted upon by two or more notched wheels, placed in a perpendicular position, which wheels are acted upon by the first moving power hereafter mentioned.

To the pillar or spindle is also fixed a knife, scraper, or shovel, to collect the clay that may be so ground or broke, and by means of a valve or door, made in a convenient part of the trough, discharge the ground clay through an opening or hopper into a receiver or reservoir. And in this receiver or reservoir, at a convenient distance below the hopper, I provide two or more rollers, made of iron, or any sufficiently strong and durable material, placed at one, two, three or more inches apart from each other, so as to permit the clay to introduce itself between the rollers, the distance to be more or less, according to the dryness or moisture of the clay that is to be passed between them from the grinding-mill: water is let into the mill at proper apertures, to moisten the clay if it becomes too dry. The rollers have a capability of adjustment by means of screws, bolts or other fastenings, bearing on the socket that holds the spindle of the rollers; that is to say, they must be capable of receding from each other, or being brought nearer each other, according

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ing to the state and quality of the clay that is to pass through them. This set of rollers are not placed exactly level, but in a small degree inclined downwards from the hopper; that is to say, the second roller is placed a small degree lower than the first roller, which is nearest to the hopper of the mill, but the third roller is placed nearly on a level with the first roller, working up against the second one in a contrary direction, so as to prevent the clay from falling over and off the second roller. This third roller serves to urge the clay to enter into the opening or space that is between the first and second rollers; and in case any clay should fall, I provide a fourth roller working up to the third roller, in order to send the remaining clay down to the second set or bed of rollers. This fourth roller will not be necessary in small mills. The distance between the first and second rollers is greater than that between the second and third. These rollers receive their revolving power from a toothed wheel or wheel and band; and beneath this first set of rollers is another set of rollers, made and placed in the same manner as the first set of rollers, and worked by the same means. This second set or bed of rollers are one, two or more feet longer than the first set, and are brought closer to each other, in order to prevent the possibility of any stones, or other hard and extraneous substances contained in the clay, from passing through them.

This second set of rollers, so placed beneath the first set, must project forward three, four, or more inches, according as the opening between the first set of rollers has been put by the regulating power when at work.

The person who attends the mill must be careful that both sets are regulated to accord with each other, so as that there shall be a certainty of the clay entering between the rollers; and the rollers must be put closer, or at a

greater

greater distance from each other, according to the coarseness or fineness of the ware intended to be made of the clay; and between the lower and upper set of rollers must be an inclined board or plate of iron, or any other strong material, placed immediately behind that roller of the first set which is the nearest to the hopper or place which feeds the rollers with the clay from the mill. The said inclined plane or board must descend to the bottom of the receiver, in order to prevent the clay from falling behind the first roller of the second set of rollers, and serves to propel the clay towards the opening between the rollers of the second ret, so as to force the clay to enter between the rollers. And I do advise, that when the stones in the clay are small, that the second set of rollers ought to be put at the distance of about one half, or one quarter of an inch from each other, so as to render it impossible for any stone to pass through between them. And almost close to these rollers is placed a knife or slicer, in a lateral direction. This knife is intended to cut the clay that passes from the upper rollers, and to thin it, so as to render the clay capable of passing between the second set of rollers; and beneath this second set of rollers is a third set, or bed of rollers, made one, two or more feet longer than the second set or bed of rollers, and placed in the same manner as the second set. And this third set of rollers must be regulated so as to approach nearer to each other than the second set, and to have a knife or slicer acting upon it to cut the clay in the manner of the former set. And near this last set of rollers is placed a trough, the edge of which is on a level with the middle of the diameter of the last roller; which trough is meant to receive the stones that may be separated from the clay. This trough is about a foot or more deep. The workmen must be careful to empty the

trough

trough from time to time, as occasion may require, and likewise to stop the mill, for the purpose of clearing the cylinders or rollers from any stones that may have remained on them.

And when the reservoir that is below the rollers is filled with the clay so cleansed, I empty it by means of an apparatus as follows: I place two inclined planes at each side of the reservoir; those planes are broad enough to permit a wheel to pass up them; and those planes reach the whole length and extent of the reservoir, and are moved higher or lower by means of a screw or screws placed beneath them; these planes are meant to bear up an apparatus for the purpose of emptying the reservoir, and carrying the clay forward towards the carts that are to take it away, which apparatus is as follows: first, a bar or beam of wood or iron, or other strong material, made to reach across the width of the receiver; on each end of this beam is placed a wheel, and from this beam descends a frame, on the lower extremity of which are placed rakers or scrapers; and this frame has a power of adjustment, which is regulated by eyes and bolts, to raise it up or let it down according to the quantity and depth of clay in the reservoir; and this frame of scrapers or rakers serves to carry forward the clay, and force it into a semicircular trough which is sustained by arms or bars proceeding from the great beam that reaches across the reservoir; and from the centre of each of the wheels that are fixed at the end of the great beam, there proceeds an upright bar of iron or wood, upon each of which uprights are fixed at about two, three, or more feet, a long bar or lever of wood or iron, which levers are placed in a horizontal direction, but inclining a little upwards; the other end of these two levers is fixed to a cross-bar, which bar has another lever projecting forward from its

centre;

centre; this last lever has its other end fastened to the rim of a large wheel, one-half revolution of which wheel draws the frame of scrapers and trough up the inclined planes, to the place where the carts are to receive the clay; and the other half revolution of the wheel sends the same frame and apparatus back down the inclined planes. The clay may be taken out of the reservoir of the mill by this means, or any other of the common methods of raising heavy bodies.

Or the clay may be removed and taken out of the reservoir or receiver by the following method, when the manufactory is in constant work, so as to take the clay away as soon as it comes out of the mill.

Second method is as follows: I place a trough or box below the last set or bed of rollers, which trough is proportioned to the size of this last set of rollers; the trough hangs on ledges or sliders in the manner of a hanging drawer, and has a bar or axis exactly below the middle of it, so as to bear it nearly on a balance; and to each end of this bar or axis I fix small wheels or rollers, which wheels are so grooved as to admit a sheeve of rope or chain to pass round it, and the same chain or rope is continued the whole length of the reservoir, and is sheeved or wound round any of the pullies now commonly in use, or a Smeaton's pulley; and after the rope or chain is so passed over the pulley, the other end of it is made fast to the great wheel before-mentioned, so that by one, two, or more revolutions of the great wheel, the trough or box filled with clay is drawn forward to the edge of the reservoir, and emptied into the carts, which is done by the following means: there is a flap, or shutter, or door in that part of the reservoir to which the carts approach to take the clay; this door is of the dimensions to permit the one part of the bottom of the trough or box

to fall inwards to the reservoir. When the other end of the trough is turned up to be emptied, one end of a rope or chain is fastened to the back part of the trough, which rope or chain passes along the trough, and over a grooved wheel which is placed on a post or upright beam; or this wheel may be placed on the top of a triangle at a due distance, and high enough to clear the cart and horse which stand at the edge of the reservoir. This rope after passing over the wheel is continued down from thence, and passes through a pulley that is fixed on a box or ring that encircles the spindle of a centrifugal regulator; the end of the rope is by means of a hook and eye, or any other common fastening made fast at pleasure to this box; and there is, one end of a rod of iron or other material fastened to the box, and the other end is connected with a centrifugal regulator made in the usual manner; the balls of the centrifugal power to have their weight increased by other small weights attached to them, or not, according to the quantity of clay in the trough. When the centrifugal power is set in motion, its increased velocity throws the balls farther from the centre, by which means the rod and rope attached to it are drawn up, by which means the other end of the rope that is fastened to the trough causes it to turn up in the manner which some carts do, on its axis having been previously unfastened from the bolts or screws which held it fast. When the trough is in this position, it will easily be emptied by the carmen into the carts; and, in order to keep the trough in this position, a pin is put in below the box of the rod belonging to the rod of the centrifugal power, in order to prevent the rod from falling down and letting back the trough; and when the pin is to be taken out from below the rod, the centrifugal power must be put gently in motion in order to let the trough down gently; and the trough

trough is sent back again by means of a rope from the trough passed through a pulley near the rollers, which rope passes by means of pullies on again to the trough of the reservoir, and serves to pull back the trough again in below the rollers, in order to receive more clay.

And I do farther declare that the several operations hereinbefore described may be performed, either by manual labour or by the application and use of any other first mover, commonly known and used, such as the force of water or steam, or the strength of animals, the same being duly connected according to the several purposes, by means and geer sufficiently well known to operative men. It is to be observed, that clay thus worked and purified, will be found superior to clay that is ground in the usual manner.

The great wheel before-mentioned may be put in motion by a horse, water, or any of the common first moving powers. In witness whereof, &c.

Description of a Drill Horse Hoe, or Weed-Harrow.

By J. C. CURWEN, *Esquire, M. P. of Workington-Hall, Cumberland.*

With an Engraving.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

AS one great and most important advantage of drill husbandry proceeds from the opportunity offered of cleaning foul grounds, as also of breaking and loosening of stiff soils, to give the power of extension to the roots of grain; whatever can facilitate these operations will, I flatter myself, be deemed worthy of the attention of the Society.

Having hitherto found great difficulty and much labour necessary in accomplishing the cleaning of wheat and other grain, I have been led to make some experiments, and I am sanguine in my hopes that the harrow I send for the inspection of the Society, will be found to accomplish the purpose with greater ease and facility than any thing at present in use.

The simplicity and ease with which it is worked has enabled me, this season, to give my wheat crop, which exceeds one hundred acres, two cleanings, and at an expense of somewhat less than a shilling *per* acre each operation; a man and a boy, with one horse, being able to clean above seven acres *per* day. The direction of the harrow to prevent its injuring the grain is effected by an alteration of the chain by which it is attached to the wheels. The distance of the teeth from the centre tooth must be regulated by the width of the drills. In case they exceed a foot, the harrow should be broader, to admit of another row of teeth. To clean at nine inches, two inches and a half is allowed on each side of the centre tooth, by which means every part of the earth is cut between the rows of grain. The size and strength of the teeth must be regulated by the nature of the soil. The thing is so simple, that I hesitated laying it before the Society till I was encouraged by persons whose experience and knowledge is infinitely greater than my own.

The complete introduction of drill husbandry would, I conceive, be of great national importance; and, under this conviction, whatever can facilitate its operations may not be unworthy of attention.

Fig. 1, (Plate VI.) shews the carriage within the shafts (A) of which the horse is placed: the carriage wheels are intended to be half the width of the butts or stitches, so that

that once going up and once returning will be sufficient to clear each butt from weeds.

B, the hoe or harrow which is attached to the carriage by the chains C C. The harrow may be raised higher or sunk lower, or placed more on one side or another, as occasion may require, by altering the position of the chain, as will appear by an inspection of the plate.

DDDDDD, six double rows of teeth or knives, which are so placed in the frame that each double row may pass up the interval betwixt the rows of corn, and cut or pull up the weeds that grow in such intervals without injuring the corn. These knives are strong, and have a sharp edge in front.

E E are the two handles, by which the person who holds them may direct the knives or teeth of the harrow to pass in straight lines up the intervals.

Fig. 2 shews the under-side of the weed-harrow, that the positions of the double rows of the knives, and of the space left to prevent the corn being injured, may be more clearly seen.

Certificates respecting Mr. CURWEN'S *Harrow.*

At the request of J. C. Curwen, Esq. I beg leave to state, that I have been present when Mr. Curwen's harrow for cleaning drilled corn has been used, and have worked a little with it myself; that its effect appeared to me most highly beneficial in clearing away in the spring all the weeds that had grown during the winter amongst the wheat, without the least injury to the grain; and also in raising up the top soil, which had become sad and heavy, and thus enabling the spring-shoot to take root more easily: and at the same time it covers the roots of the corn with fresh soil, which are often left quite bare by

by the washing of the rains in winter, and so subject to be killed by the frost; it also enables the farmer to sow his barley much earlier than he could broad-cast, as it will both clear the corn previous to sowing the grass-seeds, and afterwards harrow them in. Its utility in every respect appeared to me so very great, that I was induced to adopt the plan of sowing my corn with the drill upon my fallows this spring, and have accordingly got a harrow made upon the model of Mr. Curwen's.

Dovenby-Hall, May 13, 1806. J. D. B. DYKES.

We whose names are hereunto subscribed do certify, that we have paid particular attention to a harrow made use of in the farm of J. C. Curwen, Esq. for the purpose of harrowing between the rows of drilled grain. We conceive it of great utility; the expedition is undeniable, as upwards of seven acres can be done with ease in eight hours, with only a boy to lead the horse, and a man to regulate the harrow.

THOMAS GAFF, Merchant, Workington Hall Mills.

MATTHEW FOSTER, Farmer, at Calva, near Workington.

Workington-Hall, May 19, 1806.

Account of a useful Drill Hoe-Harrow.

By Mr. CHARLES WAISTELL, *of High Holborn, London.*

With an Engraving.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

I HAVE ordered a new agricultural implement to be left for a short time at the Society's Repository for inspection. It is called a hoe-harrow, and is, as its name imports,

imports) a hoe and harrow combined. For destroying the weeds, and pulverising the soil in the intervals of drilled turnips, and of other crops drilled sufficiently wide to be horse-hoed, I know not of any other implement of equal efficacy.

It enables the farmer to cultivate those intervals as completely as a well-wrought fallow, so long as the horse can travel therein, without injury to the growing crop. I know not who the meritorious inventor is. The first I saw was a few years ago at West Park, near Barnard Castle. This was brought from Carlisle by my brother, and many have been made from that pattern, and are now in use, and are highly approved of by farmers in the neighbourhood of Barnard Castle, where the turnip crops are now generally raised in drills about twenty-seven inches apart. This mode was first introduced there about twenty-three years ago, before which time they were all sown broad-cast.

An implement of husbandry, possessing such superior utility, as this hoe-harrow seems to me to possess, is deserving of being made known as generally and as speedily as possible. I conceive this would be best effected through the medium of your respectable Society.

Convinced that the fertility and productiveness of our arable grounds may be much increased by a more general practice of the horse-hoeing husbandry, I wish to see the practice of it advanced more nearly to perfection, as that must tend to promote its more general adoption.

Fig. 3, (Plate VI.) shews the hoe-harrow to which the horse is to be attached by the upright iron *a*, in which are a number of holes to admit the drag-chain to be put higher or lower, as may be found necessary. This iron is at one end fixed firm in the fore-part of the machine at *b*, and at the other end to the farther side of the wing *c*.

d is

d is the nearer side or wing of the machine, and moveable by a joint at *e*. This wing may by this means be expanded or contracted, as the interval between the rows to be cleared of weeds may require.

f a strong wedge-like tooth in the fore part of the machine, to tear up the weeds which are deep in the ground.

g g other teeth, more slender, fixed in the two wings or sides of the machine, and which are also intended to tear up weeds, and loosen the earth.

h h h three triangular hoes. That which is in front has a strong iron fixed in its centre; the two others at the hinder part of the machine have the irons fixed at the farther corner of each. The intent of the centre hoe is to cut off the weeds on each side next the crop, and to lay all the weeds in a ridge-like form in the middle of the path, to dry and rot.

i i the two handles, by which the machine is managed.

k a slender iron bar, with a peg and holes to direct the distance of the expansion or contraction of the machine.

l a strong iron vice, which works in a grooved iron, fixed to the inner side of the wing *d*, and which, when screwed down, holds the machine firm at the distance of expansion wanted for use.

Fig. 4 shews on a larger scale one of the hinder hoes separate from the machine, and the manner by which it may occasionally be raised or lowered in the machine by a pin and holes.

Report

Fig. 1.

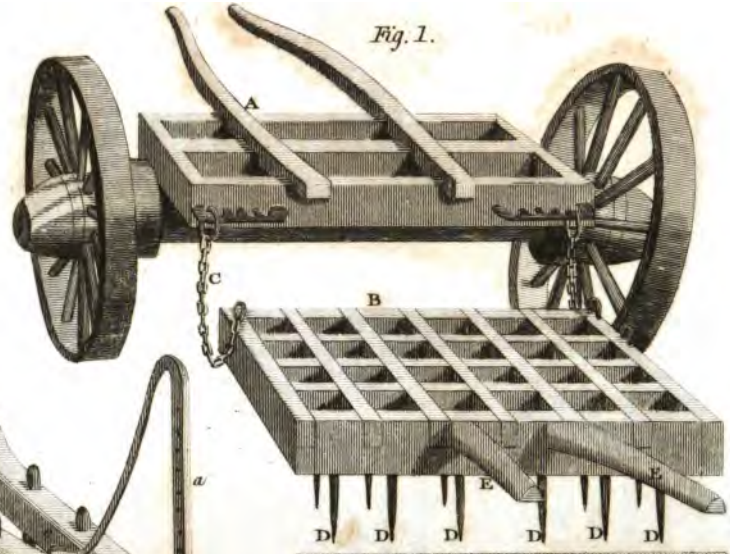


Fig. 3.

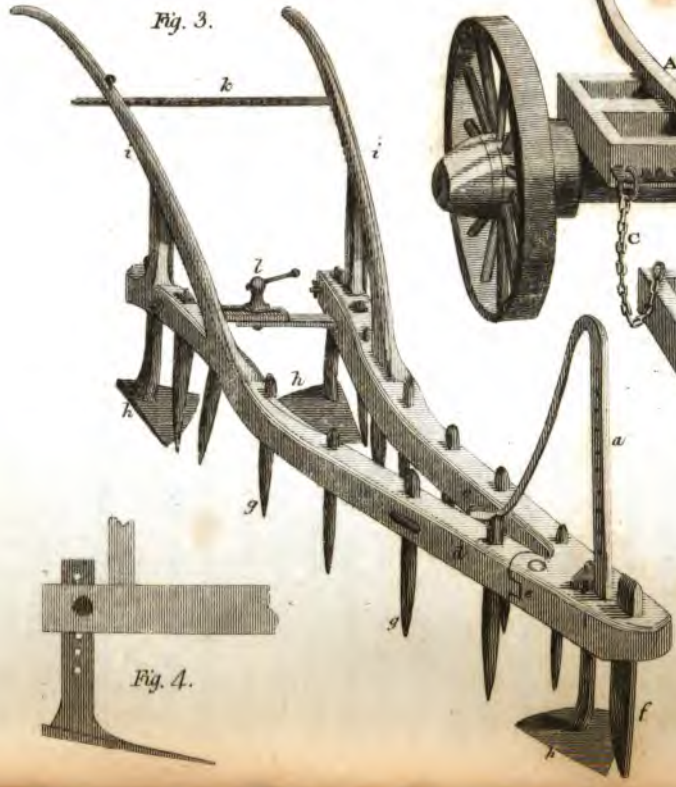


Fig. 4.

Fig. 2.

REPORT on the Sprinking of Malt on the Floor, by Mr. JOHN CARR, *in obedience to an Order of the Commissioners of Excise.*

From the PAPERS presented to the HOUSE of COMMONS.

THE Commissioners of Excise have recommended the following Report of Mr. Carr to the particular attention of the Right Honourable the Lords Commissioners of the Treasury, as being very comprehensive, and perfectly conclusive on the subject to which it relates. It is a report on the facts arising out of the evidence given before a Committee of the House of Commons, to whom the several petitions relative to the making of malt were referred. Mr. Carr has been several years detached from the surveying of malt, but formerly his experience in that branch of the revenue was considerable, having been supervisor at Hitchin and Baldock, and also in Suffolk, Hampshire, Devonshire, and Lancashire, and officer in Warwick, Worcester, and Staffordshire; and at all these places he was in the habit of surveying much malt. He has likewise, since receiving the order of the Commissioners, employed his mind very closely on the subject, and visited all the principal malting places to the north and west of London, where the process of malting is carried on under a very different system of practice.

There is probably no branch of revenue wherein such dissimilar practices and discordant notions prevail as that of Malting, and this, in a great degree, arises from the omission to trace the natural causes of the case up to its true source. Hence it is, that the two different modes of watering and not watering the corn upon the floors, appear in the evidence

to be supported by practical facts, which are in direct opposition, and by a contrariety of opinion, which leaves much of the operations of practice in a state of contradictory confusion. To appreciate the merits of these, and to rescue the case out of that ambiguity with which it appears surrounded in the printed Report of the evidence, I humbly conceive it will be proper to go pretty distinctly into the theoretical and philosophical principles for the subject.

John Reynoldson, Esquire, one of the agents for the watering party, is the only person who has attempted an explanation of the Natural Philosophy of Malting, but his account, I humbly think, is too defective in science, and too confused in itself, to afford any just and satisfactory conception of the case; and, without at all intending any impeachment of his veracity, there, doubtless, are several parts of his evidence which do exhibit very apparent symptoms of leaning with no inconsiderable bias to that side of the question which he appeared so solicitous to support. Nevertheless he has made two or three very strong concessions to the opposite party, declaring that the restrictions against watering on the floors have no stronger advocate than himself, and that he was convinced a judicious limitation of them would operate to increase the value of Malt ten per cent. throughout the kingdom; and in another place he declares his belief that, considered scientifically, Malting and Brewing are yet in a state of infancy.

The impression which Mr. Reynoldson's evidence appears to have made on the Committee, was probably much aided by the appearance of scientific research with which it was accompanied; but, as I humbly think, his philosophical views of the subject are neither sufficiently founded in nature or the real circumstances of the case,

and

and conceiving that a correct and comprehensive knowledge of that part of the process of Malting, wherein nature is so largely and mysteriously employed, is the only true foundation for all just reasoning on the subject; I will begin by stating what I consider as the true

Theory of Malting.

The interior of a barley grain consists of two distinct parts, a minute germ, destined to elongate into the future plant, and a portion of farinaceous and mucilaginous matter, stored up expressly for its future conversion into saccharine, as the pabulum of the germ in the earliest stage of its vegetative existence.

The germ itself consists of two very different parts, the plumula (acrospire in Malting) and the radicle or root; both are united at the same end of the grain; but in germinating, the radicle very soon pierces the husk, and separating into several fibres elongates downwards, while the acrospire, but much more slowly, advances through the body of the grain, and piercing the opposite end, soon shoots up into a green blade, leaving the husk of the corn empty, and perfectly exhausted of its former contents.

The radicle is much more rapid in its formation and growth than the acrospire, because, as it is destined to prepare and transmit to the stem nearly all its pabula, it is necessary that it should be sufficiently matured to perform this office by the time the acrospire has consumed the store which provident nature had laid up for it in the grain.

There is no difficulty in comprehending the first dawnings of vegetative life in the germination of barley; the grain, placed under favourable circumstances of moisture and warmth, imbibes both, and swells much; the radicle, lying the nearest to the exterior, is the most susceptible

of these, it swells most and first, and under its new combination of moisture acquires an attraction for the oxygen of the atmosphere. The oxygen, as it becomes fixed, produces two powerful effects; it gives up that portion of latent heat which held it in a gaseous state, and by its fixation enters into a new combination with the farina of the grain, converting it into an oxyd, or in other words into a saccharine.

The stem part of the germ, previously swelled by the moisture, and now invigorated by the heat produced from the fixation of the oxygen, acquires an attraction for the newly-formed saccharine, assimilates it to itself, and in the chemical action of union which ensues, vegetative life is developed.

Such simply is the natural process of germination in every species of seed, though here restricted to barley; and it is important to remark, that the heat arising from the fixation of the oxygen is the same which first becomes sensible in the couch, and afterwards continues to shew itself in different degrees amongst the corn on the working-floors; and in the nice adjustment and due regulation of this heat consists the most important part of the manupilations of malting.

The formation of the saccharine in the grain is slow and progressive, as the acrospire requires it; and hence it may easily be conceived that between its first formation and final consumption, there must be a period of time when the largest proportion abounds in the grain; and this is the proper time for throwing the corn upon the kiln.

Mr. Reynoldson, in his evidence, states that the saccharine previously exists in the barley, and that the process of malting only developes a substance which was already present in the grain; but this, like several other of his philosophical assertions, is so contrary to the natural

fact

fact as obviously to refute itself. The chemical and natural characters of malt differ so essentially from those of barley as clearly to prove that there has been not a mere development of a thing present, but an entire change of the original substance into another.

Practice of Malting.

Malting then, is nothing more than the promotion of a healthy germination of the barley up to that period when the largest proportion of saccharine has been formed; nor can any thing be more obvious than that, in a variety of modes to accomplish this, one must be superior to all the rest, and that not locally, but every where, because nature is every where the same. In every natural process, a varying of the means will necessarily produce a difference in the end, and in the two modes of Malting, by watering on the floors, or omitting to do so, there is so material a difference, not merely in the use or disuse of the water, but in the time, management, and other circumstances, that the one cannot but be superior to the other in the quality of its respective commodity.

A single instance, I believe, cannot be produced of any natural process whatsoever, wherein nature permits the employment of two different means to produce precisely the same end. The application of this to the question of Malting will, I humbly presume, be sufficiently obvious, by separately considering the different branches of the case.

The Radicle.

This is by much the most important organ in Malting; without a root the grain will never germinate, and with too much, the substance of the corn will be exhausted, and the Malt on that account will be light and unproductive. This has hitherto, I believe, either not been sufficiently known or attended to; in this, as in every

every other natural process, nature herself affords the best explanation.

On the richest and best lands the roots of barley are short, and the plant large and strong; but on loose and poor soils the roots are long, and the stem small and weak. In the one case the root, having readily found what it was in search of, stops; but in the other, nature is compelled to expend much of the pabulum on the more ignoble part of her production. On the floor of a malt house, the grain is worse situated than on the loosest and poorest land; for it contains no soil at all, and if permitted, the root there would run out to some inches in length, and almost wholly exhaust the substance of the corn. To prevent this is one of the principal objects in the manufacture of Malt, and hence too a just criterion is afforded for estimating the merit of different methods of working; for that method which will accomplish the full malting of the barley with the least possible root is so far unequivocally the best, because such Malt will have expended the least portion of itself on an object entirely unproductive. Now there is perhaps no one circumstance wherein the Hertfordshire method of Malting differs so distinctly from the watering system, as in its short and comparatively small radicle. This may be very clearly collected from many parts of the evidence; for the watering party even seem to have made a merit of it, by endeavouring to shew that their own steepings, from the larger quantity of root which they contained, approached and even ran into floor charges far beyond the Hertfordshire steepings; and they thence endeavoured to infer that a larger opening was left in the latter for fraud, by the introduction and mixing of corn privately steeped. It is indeed certainly true that the Hertfordshire mode of working gives the floor gauges low, and the other high; but with this the question of

fraud

fraud has very little to do, for mixing is seldom if ever practised in whole floors; but the short and small radicle of the one, and long bushy root of the other, are decisive characteristics which are admitted by themselves, and which would, in my humble judgment, stamp a decided superiority on the Hertfordshire Malt.

That the radicle is actually formed from the body of the barley is too obvious to require any proof, and indeed it is universally admitted to be so; and as it is afterwards burnt off on the kiln, and becomes mere waste, every particle of matter which it unnecessarily takes from the substance of the corn is just so much loss, and though this has not been at all adverted to in the enquiry before the Committee, it does in fact constitute one of the most important portions of the subject, for it actually is the expenditure of the substance of the barley on the root, by working it too much out, which is the chief cause why Malt manufactured under the forcing system of watering the floors is lighter and less productive than the Malt made by the Hertfordshire mode, without watering.

The Acrospire.

In the malting trade a great diversity of opinion prevails as to how far the vegetation of the acrospire should be carried. This arises from a notion, very general among Malsters, that just so far as the acrospire penetrates the grain, it becomes malted, and that the impenetrated part remains unchanged barley. I trust, however, that I shall soon shew there is nothing either of truth or nature in this notion. The evidence of Messrs. King and Clough sufficiently establishes that the best Malt is made when the acrospire proceeds only two-thirds through the grain, and it is my present purpose to prove that their opinion and practice are supported by the natural reason of the case.

I have

I have already stated that it is the radicle which first acquires an attraction for the oxygen of the atmosphere, communicating it progressively to the interior substance of the barley, and forming by its fixation and union with the farina the first saccharine, and that afterwards the plumula, or infant stem, requires an attraction for the newly-formed saccharine, and by its chemical action is pushed into vegetable life.

In this statement a solution is given of the question of the acrospire, and the truth really is, that the radicle is the only natural organ which malts the barley, or in other words, oxydites the interior substance, and forms the whole of the saccharine, while the acrospire is simply employed in feeding upon it, and from thence acquiring its growth and bulk.

This obvious, and I trust just and natural distinction in the offices which nature assigns to each of those different members of the plant, sufficiently explains why the barley may be, and actually is perfectly malted by the Hertfordshire method, though the acrospire has proceeded only two-thirds through the grain; because in the more slow and natural growth of the acrospire, the root has had time to malt the interior substance beyond it, and even to the extreme end of the corn, whereas in the more unnatural forcing of the watering mode, the acrospire is driven forward as rapidly, though without having any immediate connection with the oxidation; and thus an accidental occurrence has been erroneously mounted up into a cause. It is material to remark, that in brewing, the acrospire is insoluble, and always appears so among the spent grains, hence the larger it grows, the more it contributes to waste.

The preceding account of the radicle and acrospire so far simplifies the question of malting as to concentrate it to this limited rule, that that mode of working will necessarily

sarily be the best which can accomplish the full malting of the barley with the smallest radicle and acrospire; for both, as I have already shewn, are supported from the interior substance, and just in proportion as they are advanced in bulk, that portion of the malt which yields the fermentative extract will be diminished.

On page 40 of the printed evidence Mr. Delafield states, that he has found Malt, made by Sprinkling, to yield from 15 to 20 pounds weight in four bushels less than an equal quantity of Malt which had not been watered; and on page 43 Mr. Martirrena declares, that sprinkled Malt affords only 64 pounds of extract, when a like quantity of unwatered Malt gave as high as 84 pounds. Other passages of the evidence also prove, that watered Malt is lighter and, on that account, less productive, than the Hertfordshire Malt; but no explanation of the immediate cause of so material a difference is any where attempted here; however, I would humbly submit the true cause to lie in the comparative smallness both of the root and acrospire in the Hertfordshire Malt, whereby less of the substance of the grain is consumed, and that it is the long and bunchy root and large acrospire of watered Malt that render it so light and unproductive.

TO BE CONTINUED IN OUR NEXT.

Memoir on the Preparation of Caustic Alkali, its Crystallisation, and its Action on Spirits of Wine.

By M. BERTHOLLET.

From ROZIER'S JOURNAL DE PHYSIQUE.

AS chemistry acquires greater precision in its researches, it becomes of greater importance to procure agents unadulterated by foreign mixture. Caustic alkali is one of those most in use, but what has been hitherto em-

employed contains a portion of effervescent alkali, calcareous earth, and commonly iron and siliceous earth.

I have stated, in a memoir which I read to the Academy in February 1778, that by distilling, in a glass retort, a solution of alkali rendered caustic by a sufficient quantity of lime filtered, pure caustic alkali would be produced, because I supposed that the reason it could not be obtained pure when prepared in the usual way was, that the fixed air which it absorbed during the evaporation, from the atmospheric air with which it came in contact: but, though by this method the alkali be rendered more caustic, it is still very far from being in a state of purity.

It is known that spirits of wine dissolves caustic alkali, but the properties of this solution have been but imperfectly observed. I thought that the alkali ought to be disengaged from the other principles on which it had exercised its dissolving power; and from this idea I was conducted to the following observations.

I prepared a caustic lixivium with salt of tartar and lime in an iron vessel, which I filtered and evaporated: when it approached a degree of consistency, I mixed it with spirits of wine, and extracted a part of this liquor by distillation; the retort having cooled, I found at the bottom well-formed crystals, mixed with blackish earth, in a little liquor of a dark colour, which was separated from the tincture of alkali, which floated like an oil on the top.

The crystals were composed of alkali saturated with fixed air, the earth was chiefly calcareous, and a little siliceous, with some iron.

The effervescent alkali had been separated, because this salt is insoluble in spirits of wine; the liquor in which it was crystallised was water saturated with the same salt, and thereby immiscible with spirits of wine: the deposited siliceous earth was furnished by the salt of tartar, which,

which, as M. Bergman has observed, contains a certain quantity of it, when it has not been prepared with particular precautions; the calcareous earth was combined with the caustic alkali in its preparation, for as soon as it is deprived of its fixed air, it strongly tends to combination with other substances; this earth is precipitated in the aqueous liquor, under an effervescent form, by reason of its superior affinity for fixed air, than for the alkali. The iron proceeded from the vessel in which the preparation was made; one portion of this iron was soluble in acetous acid, but the other could only be dissolved in muriatic acid, and was consequently in a state of perfect calx. I precipitated it from these acids by Prussian alkali: such is the foreign matter that caustic alkali abandons by uniting with spirits of wine. I shall now proceed to examine this solution.

It neither effervesced with acids, nor precipitated lime water, but it did not resist a more delicate test; it rendered turbid a solution of ponderous earth *(barytes)* in muriatic acid, and formed a small effervescent precipitate, so that it still contained a trifling portion of fixed air: I continued to distil it, and suspended the operation, when a part of the spirits of wine had passed into the recipient: I then found the liquor in the retort divided into two portions, one of which floated, and had the appearance of a yellow oil, which remained separate even after great agitation. I separated these two portions of liquor, and the superior one afforded no indications of fixed air, although it precipitated lime-water; but this precipitate re-dissolved in water, which proves that the lime had been separated from the water by the spirits of wine, and not precipitated in effervescent calcareous earth by fixed air; and, in fact, by mixing the alkaline solution with a certain quantity of water, it no longer precipitated

lime-water; neither did it render turbid the solution of heavy earth, when diluted with distilled water; when pure, it formed a precipitate in it, but was entirely redissolved in the distilled water, so that, in this case, it is the salt of ponderous earth which is separated from the water that held it in solution, and not the earth that is precipitated from its acid. Whence we see, that caustic alkali has more affinity with water than lime, or the muriatic salt of heavy earth.

I evaporated this liquor in a small matrass, its colour became deeper and deeper; I suspended the evaporation, with the design of examining the changes that had taken place. The next day I perceived very transparent crystals, mixed with a little liquor of a deep yellow, from which I separated and examined them; and I found that it was pure caustic alkali that had taken this form.

These crystals assume different figures, being sometimes in needles, though more frequently laminated; but it was observable by the appearance of those that were detached, that they were formed of small quadrangular pyramids, implanted one upon the other; they are therefore something similar to the crystals of sal ammoniac: they quickly deliquesce when exposed to the air, and dissolve with facility in water and spirits of wine. By evaporating the latter the crystals may be restored; they produce cold, as they dissolve like those of other salts.

The lower liquor upon which the above floated, precipitated ponderous earth; it also crystallised when evaporated, but the crystals were not so regular, and appeared less pure: if this liquor be distilled, what passes into the recipient is for the most part water, especially at the end.

I dissolved the first crystals of caustic alkali in spirits of wine; the liquor was clear, and without colour; when boiled it became of a yellow colour, which became deeper

in

in proportion as the ebullition was continued: to a certain degree it entirely resembled the yellow liquor in which the caustic alkali had crystallised; after a long ebullition it lost the property of crystallising, and being evaporated almost to dryness, and then mixed with distilled water, some molecules of a yellow-brown separated from it, which would only partly dissolve in spirits of wine.

If the caustic solution that has the appearance of oil be distilled to dryness, it becomes blackish and effervescent; but, if the crystals be pure, it neither takes this colour, nor causes effervescence. It is true, however, that in this state the alkali has so much activity, that it is not possible to deprive it of the liquor its crystals retain, without attacking the retort, if it be glass, and then it becomes gelatinous with the acids.

Spirits of wine distilled with caustic alkali carries over a little with it, so as to render the syrup of violets green; it appears at the same time to become more aqueous.

From the preceding experiments it results, 1st, that when a caustic lixivium is mixed with spirits of wine, the latter seizes the caustic alkali; that this solution retains a part of the water, and by its means a portion of effervescent alkali; and that the other part of the water separates, and holds in solution the greatest part of the effervescent alkali, as well as the foreign salts that may have been mixed with it, while the earths and the iron are precipitated.

2d. That in concentrating the solution of caustic alkali by distillation a fresh separation is effected; that the liquor which floats on the top is a solution of very pure alkali in spirits of wine, and that the inferior liquor is a mixture of this solution with an aqueous solution of a little effervescent alkali. However, if the first liquor be distilled, it still occasions a separation; and it

appears

appears that the alkali disengages water from the spirits of wine. If the lower liquor be distilled, it is water for the most part that passes into the recipient.

3d. That alkali decomposes spirits of wine by means of heat, and separates from it a part which I shall call *resinous*, although I know little of its properties. It is this portion that colours the tincture of caustic alkali; and it is probably this which has formed the crystals of saccharine acid that Bergman has extracted, by treating spirits of wine with nitrous acid.

4th. That caustic alkali, deprived of water by spirits of wine, takes a crystalline form, like most other saline substances. It is rather difficult to have its crystals immediately, without sullying their purity by a portion of the resin: they may be purified by a fresh solution in spirits of wine, and by an evaporation so conducted that a little mother-water remains; but for experiments in which a very small portion of resinous substance cannot hinder their precision, the liquor that has the appearance of oil may be used, without being previously crystallised. I have frequently failed in this crystallisation, because it is not announced by a pellicle, nor by the other qualities of the liquor.

If the circumstances of the operation be varied, there will also be some variations in the appearance of the solution; thus, if we pour spirits of wine on the caustic lixivium, brought to the point of desiccation, this spirits of wine assumes a deeper colour, and the separation of the two liquors does not take place until the moment in which the crystallisation commences.

Meyer has observed some of the phenomena above described, but the *causticum pingue* with which he was preoccupied prevented him from properly remarking all that occurred: for instance, he mistook the alkali, saturated

rated with fixed air and crystallised, for an imperfect nitre. He has observed the caustic tincture that assumes an oily appearance, and describes it as a thick dark red matter, having the appearance of a demi-fluid resin, and which he considers as formed by the total decomposition of the spirits of wine.

I have verified an interesting observation of his, which is, that if flowers of brimstone be put into the alkaline tincture, it quickly dissolves a considerable portion, without the help of heat.

M. Macquer has noted, with still greater accuracy, the phenomena that fixed alkali presents when treated with spirits of wine; and he has described them in a memoir printed in the fifth volume of the *Melanges de la Société de Turin.* After having boiled spirits of wine on salt of tartar, well dried, he evaporated a part of it, and obtained crystals which he has described, and which are precisely the same as the crystals of caustic alkali. The alkali that was dissolved by the action of heat beneath the spirits of wine, coagulated in cooling, in a white saline mass, confusedly crystallised, which he redissolves in water, and then obtained a more regular crystallisation.

He evaporated a preparation which is called in pharmacy *tincture of salt of tartar*, and which is only a solution of caustic alkali in spirits of wine. When nearly three-fourths of the liquor was evaporated, he observed that it appeared to be a mixture of two very different and very distinct liquors; one without colour, like water, and the other of a deep yellow, which he compares to oil. When it was completely evaporated there remained in the capsule a yellow-brown residue, confusedly crystallised. But this illustrious chemist accounts for all the facts he observed by a reciprocal alteration and decomposition of the spirits of wine and the fixed alkali.

Of

Of the two crystallisations that he obtained, one was the caustic part of the salt of tartar that was dissolved in the spirits of wine, and the other the alkali saturated with fixed air, which had been separated from the caustic part. The first was produced by means of the spirits of wine, and the second by means of the water.

I had imagined that a caustic tincture and alkali saturated with a fixed air might be obtained at the same time by means of spirits of wine; but hitherto the experiment has but imperfectly succeeded. The alkali on which the spirits of wine have been boiled, and dissolved afterwards in water, crystallises regularly; but when the crystals are exposed to the air, they deliquesce, because they retain a portion of caustic alkali, of which they cannot be deprived even by boiling a second time in spirits of wine *.

If the employment of uniform agents, the general effects of which may be accurately appreciated, be a means of diminishing the uncertainty of medicine, an useful application of the above observations may be made, by the substitution of a caustic tincture, the strength of which, being determined by an aërometer, would be constant; for the tincture of metals, or *lilium de Paracelse*, the tincture of regulus of antimony, that of diaphoretic antimony, that of tartar, and several other pharmaceutical preparations, the names of which have often led practitioners into error, who have thought to satisfy different indications by their means, although all these tinctures

* I have as yet only been speaking of vegetable alkali: I have in like manner attempted to crystallise, by spirits of wine, the mineral caustic alkali, but this operation succeeded with much more difficulty; the separation of the two liquors did not take place till the end of the evaporation; that which had the appearance of oil was proportionably in much smaller quantity; and I only obtained from it a confused crystallisation.

are

are in reality only one solution of caustic alkali by spirits of wine, more or less charged, according to the process and the different circumstances of the operation. In my opinion very little effect ought to be attributed to the resin separated from the spirits of wine that colours these tinctures, which Messrs. Spilman, Maquer, and Meyer have seen to deposit on the sides of the vessels in which they preserved the tincture of tartar, and to which M. Monnet has attributed all the medicinal properties of the *lilium de Paracelse*. (*Journal de Medicine* 1764.)

It might perhaps too be advantageous to substitute the alkaline tincture, to a certain point, for the caustic stone, which has more or less dissolved the crucible in which it has been melted, and which is more or less effervescent; the very great causticity of this tincture may be moderated at will, by different proportions of clay.

I tried upon other deliquescent salts the means that I employed in crystallising the caustic alkali, and some of them crystallised with facility: for example, I saturated nitrous acid with calcareous earth; I evaporated to dryness; the residuum, dissolved in spirits of wine, and evaporated to a proper degree, afforded regular crystals, that formed a tetraedral prism, two faces of which appeared to be divided by a ridge, and terminated by two summits: the calcareous muriatic salt, treated in the same way, crystallised in fine transparent needles, which appeared pyramidical; it dissolved much sooner than the calcareous nitre. The muriatic salt of iron affords by this means yellow and transparent crystals, which are tetraedral prisms, having inclined bases.

Yet all deliquescent salts do not crystallise by this process: thus I never could succeed in crystallising the foliated earth of tartar; it only coagulates by forming indistinct layers, which cannot be considered as the result

of crystallisation. The difference that I have established between the salt formed with the fixed alkali and the acetous and radical acids, is therefore confirmed by these facts: I have not been able, in like manner, to obtain crystals from the muriatic solution of zinc.

On the Fabrication of Alum in the Department de l'Ourte.

By G. J. CHRISTIAN.

(Concluded from Page 66.)

WE now come to the evaporation of the leys: the cock of the mother-water vessel is loosened, and this water is suffered to run into the evaporating vessels to eleven or twelve inches in height, and these vessels are afterwards filled up with the ley. The liquor is kept always boiling, and as it diminishes, the ley only is added to it; for at each operation the mother-water is only once added. The evaporation lasts twenty-four hours. At the end of this time the refiner discharges the concentrated liquor (the degree of which he knows by plunging into it a leaden aërometer) into the cooler, in order that it may deposit a quantity of oxyd of iron which it holds in suspension: it remains there for two hours, and passes from thence into the small wooden tubs for crystallisation. Before we proceed any further, it is proper to mention, that in other works, the operation lasts forty-eight hours; and it is to be supposed that by employing the leys and the mother-waters cold, the evaporation must be retarded.

By the method in use at Flone the consumption of fuel, which is very great, is diminished; and the best alum is obtained. They are indebted to M. Pagus for this disposition of the vessels; it was he who first constructed these graduated boilers, and he constantly improves the method

method of arranging them. The liquor remains five or six days in the small tubs for crystallisation; at the end of this time the mother water is drawn out, and the crystallised salt is scraped from the sides and the bottom of the tubs. I have observed that the sides which are most exposed to the light, bear the most salts.

When the mother-water is taken out of the small tubs, it should be shaken, in order that it may carry with it an earthy precipitate which deposits and mixes with the salt: by thus agitating it, the precipitate is made to float in the water, and is discharged with it; it deposits in the reservoirs of the mother-waters.

The salt thus obtained is very impure, and irregularly crystallised: it is washed in clear water, to carry off the sulphate of iron that it contains, and it is left to drop into the baskets. The refining also decomposes the sulphate of iron.

When 28 or 29 *per cent.* of this salt is obtained, they refine it; for that purpose it is put into a small boiler; five or six cubic feet of clear water is poured on it; and when the liquor boils, it is discharged into small casks, having marked staves that may be taken out, which are bound with iron hoops, and the joints of which are luted with clay. When these casks are filled, pieces of wood, nearly equal to their diameter, are placed on the surface of the liquor across each other, in order to sustain the alum which crystallises towards the centre of the upper part of the cask. It sometimes happens that the liquor runs out through a joint: to remedy this they have a very ingenious method, which is, to throw into the liquor a few cinders of pit-coal. These cinders in falling meet in their way a current, which carries them with it, and causes them to stop up the place where the liquor runs out.

The master refiner has other difficulties to surmount, which require both skill and great accuracy; it is important for him to watch that the workmen keep up the fires to the degree of intensity necessary to make the vessels boil, and to evaporate the ley as fast as it is supplied. If this were to be omitted, the alum obtained would be of a bad quality; there would be in the mixture too much mother-water in proportion to the quantity of ley evaporated, and the mother-water would contain not only about 0.12 of sulphate of alumine, but 0.30 of sulphate of potash, 0.02 of sulphate of iron, and 0.357 of sulphate of magnesia: they know that the salt afforded ought to contain but little alum and much of foreign salts.

The principal art of the refiner consists in producing a degree of concentration, so that the heterogeneous salts shall not crystallise with the alum: if the mixtures be not sufficiently concentrated, it is of little consequence; if, on the contrary, they are too much so, the other salts crystallise with the alum, and render it impure. The degree of concentration to be given varies also according to the temperature of the atmosphere; the colder it is, the less is the concentration, and the warmer it is, the greater.

In this case, a long course of practice supplies the place of theoretical knowledge, of which unfortunately the refiners are ignorant. The habit of working at it, and yet more the leaden aërometer which they use, enables them to ascertain when the matter has arrived at the necessary point of concentration; they perceive also, at the moment of crystallisation, whether the operation has been properly done; when the pellicle, which forms on the surface of little tubs, falls to the bottom at the end of three or four days; and when they perceive upon the liquor small crystals, of which the hypothenuse of the solid angle presents a little hollow, they are certain of obtaining the desired

desired quantity of alum, and of a good quality. The refined liquor is commonly allowed from twelve to thirteen days to crystallise. After this period, they pass round the cask a chain turning on an axle, which is to bear its weight; one workman is enough to lay the cask down, and another to direct it. When the mother-water which remains is discharged, the staves are removed, and the mass of alum is cut into pieces.

Before I conclude, I shall briefly relate the method of proceeding in the formation of the leaden boilers, which are made for all the alum works by the workmen employed in them: they are new every year, and deserve some attention.

Method of making the Leaden Boilers.

The old boilers, which have been previously well cleaned, are cut up and melted in a cast-iron vessel.

The lead is heated to such a degree as not to adhere to a plate of iron which is plunged into it; in this state it is of a fine green colour. Whilst it is melting, they choose a place which is as level as possible, and which they ascertain by a large plumb line suspended to a wooden rule, of the size of a mould for casting sheets. They place in this piece of ground a frame of wood nine feet long and six wide; they fasten it at each corner by iron claspe: they fill the area of this rectangle with very fine sand, cleared from all impurities: it is necessarily used rather wet, for otherwise the lead would penetrate into the sand: they tread it with their feet in order to distribute it equally over every part, and that by being well pressed together, it may be better calculated to support the weight of the lead without sinking. However, the frame, after this operation, is not filled equally in every part; and

and further, it often contains more sand than is necessary. To remove this overplus, they have a piece of wood perfectly straight, in which are cut two vertical hollows, which fit into two sides of the frame; four workmen move it backwards and forwards horizontally: it smooths the surface of the sand, fills all the interstices and cavities, and carries off what is superfluous; this operation is repeated three or four times, which being done, they place the wooden rule on the edge of the frame opposite to that by which it is emptied; it fits it exactly, and it is confined or made to adhere to the surplus with clay which is put at the back, and it prevents the lead from extravasating when it comes against the sides of the frame while being emptied.

In order to render the surface of the sand perfectly smooth, they rub it over with plates of hot iron, and they take off the sand that remains on the edges and in the corners.

These plates are heated a second time, rubbed on one side with a little beef suet and again applied to the surface of the sand; they are passed once more over it, to spread the drops of suet as equally as possible. The mould is then ready for use.

It is hardly necessary to observe that the mould should not be far from the vessel in which the lead is melted; there should only be as much space between them as is required for the vessel, into which two workmen empty the lead with iron ladles; this vessel is a kind of vat: it is formed of wood, well fastened at the corners, and the inside is plastered with clay. It is placed with its back against the back of the boiler, and is furnished on this side with a lever, which four workmen hold by the two ends; its other side rests on the side of the mould; they raise it, and the lead is distributed equally.

When

When there is a flux and reflux there is no inequality, and the operation is successful.

It is suffered to cool. When cool, a sheet of lead is obtained which has taken fifty ladles full for its formation. They count the number of ladles full that they put in, that the sheet may be each time of the same thichness.

In order to solder two together that are to form the bottom of a boiler, they bring them as near together as possible; they pass underneath them a plate, on which they raise two parallel borders of clay: this plate is so disposed, that the solder runs through the space between these borders, which space is commonly about the breadth of two fingers.

They are careful to cut the sides of the sheets that are to be soldered, and to clear them entirely of the sand or other impurities, that may remain on them.

They likewise fix on the under side of the sheets, two borders or rims of clay corresponding with those that are made upon the board, in order to limit the width of the solder; they afterwards make lead red-hot, which they are obliged to do, because, at that degree of heat, it melts the edges of the two sheets, and incorporates with them. In this state the lead is cast, and the solder is made about three-quarters of an inch thick. The sheets thus soldered are bent to form the sides; the number of sheets to be soldered depend on the intended size of the boiler. The manner in which they should be bent in order to form the sides, may be easily imagined, but when that is done, the corners must be soldered. For that purpose a wooden mould is constructed, which is hollowed within, in the form of an equilateral triangle; it is placed perpendicularly to the exterior angle of the boiler; the interstices that it leaves are very accurately filled with clay; it is confined with some pieces of iron; in the interior

terior a bit of square wood is placed, which is the height of the mould, and which forms the base of the triangle; it is confined and luted as before. The lead is run in the same state as for soldering the bottom, it is not well to pour the lead very quickly, for the heat puts the surface of the mould in combustion, and disengages a quantity of gas, which raises the whole, and makes the soldering to fail; which only happens for want of precaution.

It is then slowly run, and when the lead is even with the edge of the sheet, it is stopped and suffered to cool.

In the same manner the middle of the sides of the boiler are soldered, excepting that the mould employed is of another form: it consists of two bits of wood, the two hollows of which, when united, form a polygonal figure; and the whole operation is performed as for the preceding soldering.

A cock must afterwards be adapted to one side of the boiler, for the purpose of discharging the lixivia; to this end a mould of planks is made of a prismatic figure, having four faces: the joints are plastered over with clay; a cylindrical piece of wood is afterwards made, which is an inch in diameter, and is fixed by the edge to a board, which is a foot square. A hole is made in the sheet for the insertion of the cock: the cylinder is passed through it, and the sheet rests upon its board. The mould is so placed that the cylinder is in the middle; the joints are luted afresh, and the whole is encompassed with sand. One workman places an iron lever on the cylinder, and another runs the lead; when the whole is cooled, the apparatus is removed, and the sheet is soldered to the rest of the boiler.

Facts

Facts towards a History of Fit-Coal.

By Professor PROUST.

(Concluded from Page 66.)

A PULVERISED coal, such as that of Villanueva, which affords 68 *per cent.* of coak, when heated in nitric acid of from 18 to 20 degrees, is by this means in a few moments deprived of the property of forming oil, oily gas and ammonia. The coal thus prepared, washed and dried, and heated afterwards to a moderate degree, yields products of a new order, but with traces of those we have mentioned, and is reduced to 66 or 67 of coak.

All pit-coal affords this result, which is obtained, as I have before observed, from no organic production known, not even from indigo, notwithstanding it contains from 72 to 73 *per cent.* of charcoal, that is to say, much more than many kinds of pit-coal.

The carbonaceous principle, freed from the other elements of the compound by this method, has all the properties of what would be obtained by the simple distillation of pit-coal; for if it be treated with potash it yields a prussic lixivium like coak itself. I proceed to the consequences.

If in these bitumens the carbonaceous part is found to be so feebly enchained by the other elements, and consequently borders on the attributes that distinguish charcoal when uncombined, we cannot be astonished either at the blackness or fragility of pit-coal.

The carbonaceous principle of organised bodies, freed from the fetters of combination by any means whatever, and consequently brought nearly to its natural density, may not separate entirely from the hydrogen and azote,

in consequence of the reciprocal affinity of these three combustibles, as is demonstrated by the habitual state of our coal-fires, which are always more or less provided with them; but the same cannot be said of oxygen. The condensation of the charcoal, carried to the degree that makes it appear black, is a state that decidedly opposes the possibility that this principle can adhere to it as easily as the others. This established, if the charcoal in these bitumens be nearly of its habitual density, we must not be surprized if, remaining always united with the azote and hydrogen, it cannot be equally so with the oxygen. According to this principle, it will not be surprising to find that coal does not contain oxygen in a state to concur, during its distillation, in the formation of vinegar; as it does when it is a constituent part of our vegetables.

But lastly, if nitric acid separate from these bitumens a charcoal furnished with azote, such as distillation would leave, it must then be acknowledged, that coak, free and condensed, exists as such in their constitution, but not in that state of perfect combination, of reciprocal interlacement, that never fails to efface the characters of the elements that constitute organised bodies, as they reciprocally mask each other.

This is enough, I believe, to shew that pit-coal, if it were originally composed of plants, has however preserved none of those characters that could bring it nearer to the nature of vegetable than animal substances. Vegetables, animals and bitumens, have all the same elements; they all contain azote, hydrogen, oxygen, charcoal, sulphur, &c.; but the combination that these elements at present exhibit in pit-coal, certainly in no respect resembles those that vitality every day forms in the beings arising before our eyes.

Where,

Where, in fact, are the vegetables or animals that contain charcoal simply deposited in their texture, as an oil or resin is in a plant? Besides, what organization could admit without inconvenience such a considerable excess of charcoal as that we see unemployed in these bitumens? Such profusion certainly could only be a mistake of Nature.

We must therefore stop at one or other of the following inferences.

Either that Nature once produced beings the organisation of which admitted such a great proportion of charcoal: then the life, object, end and means of existence of such beings were in nothing similar to those that now share the surface of the earth with us, and pit-coal in this case can only be the remains or monuments of animals and vegetables, that like so many others have disappeared for ever. Or else, if coal really has issued from organic productions similar to ours, its interment has not only destroyed all marks of organisation, but has also displaced their elements, to reframe and fabricate with them those masses of fossils which have indeed preserved all the combustibility of their nature, but no traces of vegetation or animalisation, nor any indication of the parts they filled on the surface of the earth.

Finally, although the signs by which we would desire to distinguish its origin, are now effaced, it will at least be unanimously agreed on, that if the matter of pit-coal has no analogy on this globe with any but organised bodies, it must have been produced from them. Berthollet affirms that the vital principle is not found to exist in any substances but those in which hydrogen and azot are united; and, besides, it is too preposterous to suppose that Nature would create so much organic matter only to condemn it, from the time of its first production, never to

be kindled into life, and consequently to partake of the inert and dormant nature of mineral productions.

Oxyd of Charcoal.

Charcoal and oxygen are susceptible of a kind of union which does not appear to me to have been hitherto noticed. This union is not in any respect similar to carbonic acid or gaseous oxyd; for these always take place between oxygen and *carbon*, but the other admits charcoal without difficulty, whether azotised or not; in short, such charcoal as we burn for our fires.

The following are the facts.

A hundred parts Villanueva coal, the coak of which amounts to 68, rises by the application of nitric acid from 18 or 20 to 120 or 121 parts. Hence it follows that if this acid destroys by oxydation all the principles contained in this bitumen between 68 and 100, it leaves in their place, *first* 32, then 20 of another principle, the nature of which we shall soon perceive.

The coal of Belmez likewise yields 120 or 121; the coal of Langreo the same; the English coal which leaves 64 of coak also affords as much as 116 of product, which amounts to nearly the same.

To shew that it does not act in this way in consequence of something merely imbibed, nor from defective washings, the following is a decisive experiment: 5 drachms of Villanueva coal became 6 by the application of nitric acid; a result similar to the preceding. These 6 drachms were thrown into boiling water; but after they had been collected and dried, they returned precisely to the weight of 5 drachms. Such a result evidently indicates a surcharge, which, being from 50 to 52, consequently amounts to half the coal employed. It is time, however, to make known its nature.

Hold

Hold in the hand a small retort containing 100 or 200 grains of oxydated charcoal, its belly being at some distance above a chafing-dish, so as to receive a gentle heat; its beak must be held under water, to give vent to the atmospheric air, which the aqueous vapour begins to expel; but, as soon as the rapid movement of ebullition agitates the powder, the beak must be placed under an inverted jar filled with water. This movement, which raises up the charcoal briskly, is a strong obscure detonation which quickly terminates without the least danger. At the same time a copious dew is produced, which, by its precipitation as it goes off, always carries some powdered charcoal out of the retort.

The gases of this experiment are easily foreseen; they are a mixture of carbonic acid and gaseous oxyd, burning with a blue flame and not detonating. If it be yellow, it is owing to some remains of nitric acid retained by the charcoal. This is also perceptible by its reddening with oxygen gas.

The great quantity of water that formed during this distillation led me at first to imagine, that the oxygen of the nitric acid, hydrogen and charcoal, might form together a sort of union comparable with that of a vegetable oxyd, which a more elevated temperature would occasion to be converted into water, carbonic acid, and gaseous oxyd. And perhaps it is so. Yet the experiment that I made immediately with powder of fir charcoal, induced me to consider the phenomena as belonging exclusively to charcoal and oxygen.

Let nitric acid of 20 or 25 degrees, be boiled on calcined charcoal of fir, elm, or other wood reduced to a powder; when washed and dried, the charcoal commonly has a surcharge of from twelve to thirteen *per cent.*

If

If it be heated with the same precautions, it detonates with agitation, and yields the two gases above mentioned, without any mixture of nitrous gas. Other experiments will presently prove, that this charcoal is rather in a peculiar state of combination, and not contaminated by remains of nitric acid.

I cannot determine with precision the method of thus oxyding vegetable charcoal, because I have found it variable. But it is not thus with pit-coal; the state of extreme division in which the acid meets with it, when it deprives it of hydrogen, facilitates this union so as to leave us in no uncertainty.

Such is the oxyd of charcoal that I have announced in my first memoir on Prussian blue. I have lately examined some fir charcoal that I had oxydised at that period, and I found them not at all changed, except that the elm charcoal did not burn so briskly. This alteration sufficiently exhibits a combination very different from the stability of carbonic gas and gaseous oxyd. I now pass to other properties.

Liquid potash, even at a boiling heat, has no action on pit-coal, but if heated for an instant, in a very dilute state, on its oxyd or that of fir, a deeply coffee-coloured solution is obtained, which is not changed by repose nor by the addition of water.

Ammonia acts with equal efficacy on both. A hundred grains of oxyd of charcoal from Villanueva coal, dissolved in it all but 15 grains, perhaps either because they were not oxydised, or because the oxygen had accumulated in the dissolved 85 grains, in order to facilitate their solution in the potash. This solution, mixed with an acid, afforded a brown precipitate, which was nevertheless black and shining when dry. It did not fuse, and exhaled no smell on burning coals.

Oxygenised

Oxygenised muriatic acid precipitated it also, but without manifesting any action on the precipitate.

This same charcoal oxyded, dissolved and precipitated, left, when burnt, grey ashes, a little ferruginous, in which I found silex, alumine and a little oxyd. What sort of union is there then between the charcoals and their ashes? It appears that potash could not dissolve the latter. I applied nitric acid to different kinds of charcoal, to divest them of ashes, and to try if they would burn away entirely; but I did not succeed.

It was my intention to have pursued still further my researches on oxyded charcoal, but other objects have prevented me. It will, no doubt, be asked, and with reason, what is this but a combination of oxygen and charcoal, which excludes neither azot nor any of the foreign bodies that they generally contain? And again, what kind of union can the same principle form with charcoal, without losing any thing of its density or colour, which appears so little conformable to the laws of combinations? I can only say that I know nothing on the subject.

I would even ask, of what nature is the combination that charcoal forms with hydrogen and azot, and other gases, that it absorbs and condenses in so great a quantity? We are certainly still very far from being as well acquainted with charcoal, which we see daily, as we are with carbon, which is never manifested to our senses.

Dishydrogenised Coal.

When we consider how much the proportion of coak varies in pit-coals, we must find it difficult to refuse to believe, that if these bitumens be really derived from plants similar to ours, the concentration or carbonaceous principle, which is nothing but the loss of hydrogen, must have varied considerably in different countries. A

coal

coal that gives ,77 of coak, cannot contain so much hydrogen as another that affords only ,67 or ,60.

This diminution of hydrogen has even been carried so far in certain pit-coals, that they may be said to be at the zero of this principle, that is, that by the total loss of hydrogen, they become pure and simple charcoal.

But if hydrogen have been capable of withdrawing from certain coally masses, (which will not seem surprising if we recollect, that the carbonaceous principle in them is nearly of that degree of condensation that does not admit of combinations); it is not the same with azote, which appears to be among the last of the moveable principles to quit it, as we shall presently see.

In the neighbourhood of the monastery of Starbas, situated in the mountainous defile that separates the Asturias from the province of Leon, there is a vein of coal, which so perfectly resembles that of Quiros in its foliated texture and shining blackness, that it is difficult not to confound them.

This coal is a bitumen in which the carbonaceous principle is ,93, whilst the hydrogen is actually 0. In fact, it is a true native coak which burns without any bituminous or sulphurous smell, and leaves 7 *per cent.* of whitish ashes.

If, notwithstanding the indications of all its characters combined, it can be supposed, that this was never the base of a bitumen, I would recommend the following experiment. Let it be heated with potash, and a prussic lixivium will be obtained. The azot, although the only remains of the principles that have disappeared, thus becomes a clue that assists the chemist in tracing the origin of this production; it incontestibly indicates that it has belonged to that organic matter which the hand of time has decomposed, to reduce to pit-coal. The coal of St. Symphorien,

Symphorien, examined by Sage and others, which I believe has been found in bits, are likewise monuments of the same antiquity.

Jet.

It is said that trunks of trees are found in collections, one extremity of which is converted into jet, whilst the other is still ligneous. If it be so, nothing could be more interesting than the analysis of such specimens.

There is a considerable difference in jets. A jet from Almagra in Murcia, yields 46 of charcoal, without even softening; another, wrought into buttons, melted like a resin, and yielded 52. The kennel coal from Ireland, which is worked like jet, is not however of the same nature, as I shall presently shew. It affords 70 *per cent.* of charcoal, and 5 of light grey ashes.

The following results to a certain point assimilate jet with our vegetables.

When heated with an acid at 20 degrees, a bulky effervescence immediately takes place. As the solution advances, a deep yellow or annotta coloured concretion forms; by continuing the ebullition a little while, all that can be formed may be collected. This substance, which is soft while the liquor is hot, is easily softened and separated. When washed with boiling water, it acquires a yellow colour, but is not dissolved. When dry it is bulky, bitter, and soluble in alcohol. But what is remarkable is its propensity of detonating, or rather of fusing with a very moderate heat, like oxyded charcoal. It need only be held on a piece of paper over the flame of a candle, to discover the nature of its detonation; it will also take place in a retort, without any danger.

Its products are water, a little oil, carbonic gas, gaseous oxyd burning with a blue flame, and 40 of a coal thrice as bulky as the original substance.

The liquor that remains after its separation is of a deep yellow, very bitter; it yields crystallised oxalic acid and benzoic acid.

Pit-coal heated with an acid of 40 degrees, dissolves slowly, leaves no appearance of charcoal, and yields the detonating substance, but always with more difficulty and in less quantity than jet. The kennel coal comports itself like common coal and not like jet. There are however, among the latter, some specimens which do not yield the detonating substance without an acid of 40 degrees, that is, with as much difficulty as pit-coal.

If we consider, that the first action of nitric acid on pit-coal consists in destroying the hydrogen, we shall easily conceive, that this same hydrogen is no way necessary to the formation of the detonating substance. This is evidently demonstrated, by the following experiment. Oxyded Villanueva coal certainly contains no hydrogen; yet, treated with an acid of 40 degrees, it affords the detonating substance; and since this yields water, oil, ammonia, &c. it is evident that the azot, the oxygen of the nitric acid, and the charcoal which the water is capable of furnishing by the concurrence of affinities that occasion its decomposition, establish themselves in a fixed proportion, to give rise to this singular product. A vegeto-animal compound, an artificial oxyd of this nature, removes the difficulties I at first found in the formation of tannin, from the simple presence of nitric acid and charcoal.

Acid at 35 or 40 degrees, heated with fir or elm charcoal, yields at first such gases as might be expected; but at a certain point the gases cease to form and the charcoal enters into solution. I have some very old solutions of this kind, which have not altered. Alkalies precipitate nothing from it, because charcoal, either oxyded or simply divided, is as soluble in alkalies as in acids. I was thus

thus far advanced, when I learned from the *Annales*, that tannin was formed in carbonaceous solutions. Crell, I believe, is the first who announced the solution of charcoal in nitric acid.

A hundred grains of Villanueva coal, treated with concentrated sulphuric acid, and completely washed and dried, left 104. Was this coal oxyded? I find nothing more in my notes, than that it burned without any bituminous smell, that of sulphur only being discernible.

Turf.

A piece of turf from Dax, that was sent to me at Madrid, afforded the following results:

A hundred parts distilled left 40 of charcoal; there was no alteration in its bulk. Its products were water, and vinegar mixed with ammonia, the taste of which did not differ from that of wood; but a yellow oily matter came over, that became hard like suet, which is not commonly seen in the distillation of wood. This suet was from 6 to 6½ *per cent.* I did not examine the gases.

Potash, which has not the least action on pit-coal, perfectly dissolved the turf, which surprised me. The solution is coffee coloured; acids decompose it, throwing down a brown flocculent precipitate, which by distillation becomes black, shining and fragile. When distilled it is converted into charcoal, without softening or diminishing in bulk; yields the butyraceous product, and is reduced to 50 of charcoal.

Nitric acid at 30 degrees does not decompose turf, as it does pit-coal. Washed and dried it yields water, not any acid, but the butyraceous product. It might be supposed, that this suet exists ready formed in the turf. This deserves to be farther examined, and particularly to be compared with those plants, the bituminisation of

which so far advanced, as to shew what changes its progress effects in its constitution.

Nitric acid of 40 degrees, applied with ebullition, dissolves turf. Crystallisable oxalic acid is obtained from it, and the yellow bitter matter, but no detonating product like that of jet; but I do not know whether Hatchett's tannin be found in it.

Its incineration is tolerably slow, its coal does not exhale the ammoniacal smell of azotised charcoals; its ashes are grey, without any traces of saline matter or of lime. Their lixivium does not alter the juice of the blue bottle. Acids do not occasion the slightest effervescence with them. They contain much silex, sulphate of lime and a little magnesia.

Intelligence relating to Arts, Manufactures, &c.

(Authentic Communications for this Department of our Work will be thankfully received.)

REGULATIONS *suggested by the Committee as the Basis of future Laws respecting the* LEATHER TRADE.

REGULATIONS. No. 1.

Proposed to be adopted for the Sale of Leather in and near London.

1. THAT six examiners of leather shall be appointed annually in Leadenhall-market, on the first Tuesday in ; that is to say, three by the majority of the tanners, and three by the majority of the curriers and persons occupied in the cutting of leather, then and there present, between the hour of , whose names shall have been entered as buyers and sellers in the register of the market, as hereinafter directed, in the course of the preceding year.

2. The

2. The names and description of the examiners shall be returned to the Lord Mayor of London; and the persons so appointed shall signify to him their consent within fourteen days after such appointment: and in case of default in making such return, or signifying such consent, the Lord Mayor shall, on or before the Tuesday next ensuing, appoint as many examiners as shall be wanting to complete the number of three on behalf of the sellers, and three on behalf of the purchasers, under pain of forfeiting the sum of .

3. The Lord Mayor shall enter, in a book kept for that purpose, the name and description of every person so returned, and consenting to be an examiner, in the same order which was observed in the return; and the name of every person so by him appointed in consequence of default, after the name or names of such as may have been returned by the buyers and sellers respectively, distinguishing whether such person or persons were returned, or by him appointed in behalf of the sellers or the purchasers, under pain of forfeiting .

4. The said examiners, so annually elected or appointed, shall enter on the execution of the duties of their said offices on the Tuesday in , and continue to hold the said offices for the space of one year and no more: Provided always, that nothing in these regulations shall be construed to prevent the same persons, or any of them, from being re-eligible, and re-elected, or re-appointed, on each or any successive year.

5. Every vacancy in the course of the year shall be filled up, under the above regulations, on the ensuing market-day, by the sellers or purchasers, according as the vacancy shall have taken place among those appointed by the sellers or the purchasers.

6. The

6. The said six examiners, or the majority of them, shall appoint a seventh examiner, and make return to the Lord Mayor of his name and description, and the said seventh examiner shall signify his consent to the Lord Mayor in writing; and in case of default of making such return, or signifying such consent within seven days after the appointment of the said six examiners, the Lord Mayor shall, on or before the next market day, appoint a fit person to execute the duties of such office, under pain of forfeiting the sum of

7. The said examiners shall take an oath for the impartial and faithful execution of the duties of their office.

8. They shall attend in Leadenhall-market, and in any other market or fair for the sale of leather, which may be hereafter appointed, within five miles of the Royal exchange, on every market day, during the usual hours of buying and selling leather, under pain of forfeiting for each offence.

9. During the absence of one examiner, if it shall appear that he was appointed on behalf of the purchasers, that examiner, whose name shall stand last on the entry made by the Lord Mayor on behalf of the sellers, shall be incapacitated from acting, and *vice versâ*, as the case may be; and during such absence, of one or two examiners, it shall be lawful for five, that is to say, two of those appointed in behalf of the purchasers, two of those appointed in behalf of the sellers, and the seventh examiner, to do, and they shall be required to do, whatever might or ought to be done by all the seven.

10. The said examiners, or five of them, constituted as above, shall examine all leather in the fair or market; and if they, or the majority of them, shall find any leather insufficiently dried, or insufficiently tanned, they shall direct the person or persons who had exposed the same

same in the fair or market, to re-dry or re-tan the same at his or their own expense, and shall levy a penalty on him or them, not exceeding two and a half *per cent.* for the first offence, and five *per cent.* for every subsequent offence, within three months after a former offence; and if the said leather shall have been sold, or contracted to be sold, before such condemnation, they shall declare such bargain to be void, and the same shall be void accordingly: Provided always, that nothing in these regulations shall be construed to prevent an action for non-performance of any contract.

11. The said examiners, and every one of them, when required by any one of their own number, or by any person or persons in the fair or market, to examine any leather which shall not have been removed from the fair or market after the sale or contract for sale thereof, shall proceed with all convenient speed to examine the same, according to the order in which such applications shall be made, before they proceed farther in the general search.

12. On complaint made to one or more of the said examiners, by a purchaser of leather, which shall have been sent from the premises of the seller, within ten miles of the Royal Exchange, to the premises of the purchaser, within five miles of the Royal Exchange, without having been exposed and bought in the public market or fair, within three days after the purchase, and hours previous notice given to the seller by the plaintiff, the said examiners shall proceed, with all convenient speed, to examine the said leather, and hear evidence touching the same; and if it shall appear to have lost above *per cent.* in weight since the hour of purchase, they shall award damages to the purchaser in double proportion to the excess on that loss: And if the leather so condemned shall appear to be nevertheless and still in a wet condition,

tion, and liable to a farther diminution of *per cent.* in weight, they shall give treble instead of double damages, and direct the same to be re-dried at the expense of the seller; and if the same shall appear to be insufficiently tanned, they shall direct it to be re-tanned at the expense of the seller.

13. Provided always, That when leather shall have been sold, either in the public market or elsewhere, under a special contract or agreement that no complaint shall be made on the subject of wet, the examiners shall have no subsequent power to pronounce upon the same in that respect.

14. And provided also, That if any person or persons having inadvertently brought, or caused to be brought, to the fair or market any leather insufficiently dry, and having affixed thereto in plain and legible characters, the words *not for sale*, shall give notice, within one hour after the opening of the said fair or market, concerning any leather brought and unloaded before the said opening, and concerning any leather brought and unloaded after the said opening of the fair or market, within one hour after the arrival and unloading of the same, to one or more of the said examiners appointed on behalf of the purchasers, that he or they intend to withdraw the same, and cause it to be re-dried previous to the sale thereof; it shall not be lawful for the examiners to levy the said penalties, as herein-above directed: And the said person or persons, after such notice so given, shall re-produce the said leather in the market, and satisfy the examiners that the same hath been re-dried according to the tenor of the said notice, under pain of forfeiting the sum of

15. The said examiners shall stamp every hide or skin directed to be re-dried or re-tanned, or concerning which notice shall be given, that the same will be withdrawn from

from the market to be re-dried or re-tanned; and the person or persons so directed, or so stipulating to re-dry or re-tan the same, shall re-produce the same in the market within after such direction or stipulation, and satisfy the examiners that the said leather hath been re-dried and re-tanned, according to the tenor of the said directions or stipulations, under pain of forfeiting the sum of .

16. The said examiners, or one of them, shall keep one book or register, wherein they shall enter all such bargains as shall be made for leather in the fair or market, and also the weight and number of such hides or skins, with the names and dwelling-places of the buyer and seller, taking of the seller for every ten hides, backs or butts, the sum of two pence, and for every six dozen of calf skins two pence; and of the buyer after the same rate, and no more; and shall note whether such leather hath or hath not been actually by them examined, under pain of forfeiting for every such offence. And the said examiners shall enter in the said book or register the weight and number of all hides or skins returned to them as tanned within five miles of the Royal Exchange, and sold, exchanged, or put away, within five miles of the Royal Exchange, elsewhere than at the fair or market, taking of the buyer and seller after the same rate as hereinabove directed, and no more.

17. No person or persons shall, after , sell or exchange, or put away, or cause to be sold, exchanged or put away, any leather in the fair or market within five miles of the Royal Exchange, except he or they register, or cause to be registered, the said leather as hereinabove directed; nor send elsewhere, within the limits last aforesaid, any leather tanned within five miles of the Royal Exchange, except he or they make a true

return to the said examiners of the weight and number of such hides and skins, at four several times in each year; that is to say, on

upon pain of forfeiting for every such parcel of such hides or skins so sold, the sum of

18. No person or persons shall, after

, buy any leather at the fair or market, within five miles of the Royal Exchange, except he or they register, or cause to be registered, the said leather, as hereinabove directed, nor buy or receive, within the said limits, any leather tanned within five miles of the Royal Exchange, except he or they make a true return to the said examiners of the weight and number of such hides or skins, at four several times in each year; that is to say, on

, upon pain of forfeiting, for every such parcel of such hides or skins so bought or received, the sum of

19. When the said examiners shall be required to examine leather, which shall have been sent to the premises of the buyer as aforesaid, without having been exposed and bought in the public fair or market, they shall take the sum of twenty shillings, and no more, from the seller of the said leather, if the same shall appear to them to have been insufficiently dried, or insufficiently tanned; and of the buyer the like sum, and no more, if the said leather shall appear to have been sufficiently dried and sufficiently tanned.

20. If any examiner refuse or neglect to examine any leather when required so to do, and to decide upon the same with convenient speed, according to the true meaning of these regulations, or do allow that which is insufficient, or refuse to allow that which is sufficient, then for every such offence he shall forfeit the sum of

21. If

21. If any examiner shall receive any bribe, or exact any other fee for the execution of his said office, than is by these regulations limited, then for every such offence he shall forfeit .

22. If any person duly elected or appointed, who shall have signified his consent, according to the true meaning of these regulations, to and for the execution of the duties of the said office of examining leather, shall refuse altogether to execute the said office, then for such offence he shall forfeit , and his appointment to the said office shall be void. (N. B. Examiners to give a month's notice to the Lord Mayor, and publish the same in the market, when desirous of resigning.)

23. If any person, after , wilfully withstand or deny any such examination to be made according to the tenor of these regulations, or wilfully obstruct the said examiners in the execution of the duties of their said office, then for every such offence he shall forfeit .

24. The hides and skins of ox, bull, steer, cow, calf, deer red and fallow, being tanned and unwrought, shall be reputed leather, according to the true intent of these regulations. (N. B. These regulations are confined to the sorts of leather which, by the existing laws, are subject to searching and sealing. Horse hides and seal skins, which are not mentioned in the Act of James, are as liable to imbibe moisture as any other leather; but the Committee have framed these regulations with a view to the existing penalties, and have not thought it their duty to recommend their extension to articles which have not hitherto been subject to them.)

25. All penalties levied under these regulations shall be placed in the hands of four trustees; that is, two persons carrying on the trade of tanners, and two persons

occupying the trade or mystery of curriers or cordwainers, for the improvement of the market.

26. If any other public market or markets for leather than that which is held in Leadenhall, shall be hereafter established within five miles of the Royal Exchange, it shall not be lawful for two or more markets for leather to be held on the same day, within the said limits.

27. No tanner shall sell, exchange or put away, any such hide or skin, except he stamps at full length upon the same, in plain and legible characters, his name and place of dwelling. (N. B. Calf skins to be excepted, which might be damaged by the stamp.)

REGULATIONS, No. 2.

That similar regulations shall be enforced in the markets, and within the limits of the liberties of Bristol and , and also at fair, and all other fairs and markets where leather is usually sold, wherein it shall appear to the justices of the quarter sessions of the county wherein said fair or market is held, that searchers and sealers have been actually appointed, and have actually executed the duties of searching leather in the year 1806, concerning all such leather as shall be sold, bargained, exchanged or exposed for sale in the said fairs or markets, and within the limits of the said liberties.

Provided always, that in such fairs and markets it shall not be lawful for the examiners to levy any penalty under the directions of these regulations, exceeding two and a half *per cent.* on the value of the leather by them found to be insufficiently tanned, or insufficiently dry.

Provided also, that each and every thing which the Lord Mayor of London is required to do by these regulations, within his jurisdiction, shall be done in the same manner, and under the same penalties, by the lords of

all

all fairs or markets not held within the liberties of any city or town corporate, and by the mayors of all cities and towns corporate, wherein examiners are or shall be directed to be appointed by or in pursuance of these regulations.

And provided also, that on application made to the justices of the quarter sessions of the county in which such fair or market shall be held, if it shall appear to the said justices that the fees collected in such fair or market under these regulations be not sufficient remuneration for seven fit and proper examiners, it shall be lawful for the said justices to direct that the number of examiners to be appointed on behalf of the purchasers be limited to two or one, as the case may require, and the number of those on behalf of the sellers in the same manner, and after the same proportion, and neither more nor less, and the same shall be limited accordingly, notwithstanding any thing in these regulations to the contrary. And in case of such limitation to five examiners, it shall be lawful for three of the said five examiners; that is to say, one of those on behalf of the purchasers, one of those on behalf of the sellers, and the fifth examiner, to do, and they shall be required to do, whatever might or ought to be done by all the five, under the same regulations as herein before directed.

That in all cities, towns corporate, and other places where fairs or markets shall be usually held for the sale of leather, on application made to the justices of the quarter sessions of the county in which any such fair or market shall be held, in pursuance of the resolutions of the majority of the sellers and the majority of the purchasers of leather, who shall have used in the course of the preceding year such fair or market, concerning which such application shall be made, declared at a public meeting of

of such sellers and purchasers for that purpose assembled, which meeting shall have been one month at the least previously advertised in a daily or weekly paper of the county in which, or of the town or city in or near which, such fair or market shall be held, if any such paper shall be, and notice of such meeting publickly affixed to some conspicuous part of the said fair or market, at and during the usual hours of selling leather therein, it shall be lawful for the said justices to direct that the same regulations, which are hereby directed to be enforced in the markets of Bristol, shall be enforced in the fair or market concerning which such application shall have been to them so made as aforesaid; and the same shall be so enforced in the same manner, and under the penalties herein before directed, so long as to the justices of the said quarter sessions shall seem expedient.

REGULATIONS. No. 3.

That no currier shall curry, or cause to be curried, or sell, bargain or exchange, or expose for sale, or cause to be sold, bargained, or exchanged or exposed for sale, any leather which shall not be sufficiently tanned, under pain of forfeiting for every such offence the sum of , to be recovered by such informer as shall sue for the same, before one or more justices of the peace.

That no cordwainer, saddler, or other person occupying the cutting of leather, shall work into wares, or cause to be worked into wares, any leather which shall not be sufficiently tanned, nor sell, bargain, or exchange or expose for sale, or cause to be sold, bargained, or exchanged or exposed for sale, any wares wrought of leather insufficiently tanned, under pain of forfeiting for every such offence the sum of , to be recovered by such informer as shall sue for the same before one or more justices of the peace.

No

No cordwainer shall make, sell, or expose for sale, or cause to be made, sold, or exposed for sale, any boots, shoes or slippers, the legs and upper leathers of which, the linings excepted, shall be made of sheep-skin, under pain of forfeiting for every such offence the sum of , to be recovered by such informer as shall sue for the same before one or more justices of the peace.

List of Patents for Inventions, &c.

(Continued from Page 80.)

THOMAS COBB the younger, of Calthrop-house, near Banbury, in the county of Oxford, Paper-maker; for certain improvements in the art of making paper in separate sheets. Dated December 4, 1807.

JOSEPH MANTON, of Davies-street, Berkeley-square, London, Gun-maker; for certain improvements in time-keepers. Dated December 5, 1807.

JOHN WILLIAMS, of Cornhill, in the city of London, Stationer; for a new mode of covering and inclosing all kinds of carriages. Dated December 9, 1807.

MARK LAYBOURN, of Great Driffield, in the county of York, Mechanic, and RICHARD MILBOURN, of the same place, Gentleman; for an improved roving machine for preparing flax, tow, and wool, for spinning. Dated December 9, 1807.

CHARLES GRANT, Viscount de Vaux, of Elizabeth-street, Hans-square, in the parish of St. Luke Chelsea, in the county of Middlesex; for a machine which will shew the latitude and longitude at sea, serving also for weighing any object, for measuring space, or the course of a ship and time; shewing and keeping account upon dials

dials and upon cosmographical columns, which are part of such machine; and also shewing the leeway of a ship; part of which machine may also be applied to other useful purposes. Dated December 9, 1807.

JAMES BRECK, of Newcastle-under-Lyme, in the county of Stafford, Ironmonger; for a new method of manufacturing iron straps or girdles into various articles as a substitute for those now composed of hemp.
Dated December 16, 1807.

GEORGE REMINGTON, of Queen's-square, Bloomsbury, in the county of Middlesex, Cabinet-maker; for certain improvements on tables and couches.
Dated December 16, 1807.

JOHN WILLIAMS, of Cornhill, in the city of London, Stationer; for a method of preserving the equilibrium, and preventing all kinds of carriages and vehicles overturning. Dated December 19, 1807.

WILLIAM JUNIPER, of the parish of St. Saviour Southwark, in the county of Surrey, Engine-maker; for certain improved rolls for punching of tier, and drawing hoops for the stocks of wheels, and a segment for sweeping and setting the same. Dated December 19, 1807.

SAMUEL SALTER, of Watford, in the county of Herts, Maltster; for an apparatus for the purpose of drying malt, hops or any kind of grain.
Dated December 19, 1807.

JOHN LEIGH BRADBURY, of Navan, in the county of Meath, in that part of the united kingdom of Great Britain and Ireland called Ireland; for a method of spinning cotton, flax, and wool. Dated December 24, 1807.

THE

REPERTORY

OF

ARTS, MANUFACTURES,

AND

AGRICULTURE.

No. LXIX. SECOND SERIES. Feb. 1808.

Specification of the Patent granted to MICHAEL LOGAN, *of Paradise-street, in the Parish of Rotherhithe, in the County of Surrey, Engineer; for a System of Marine, Fort, and Field Artillery.* Dated March 13, 1806.

TO all to whom these presents shall come, &c. Now KNOW YE, that in compliance with the said proviso contained in the said letters patent, I the said Michael Logan do hereby declare that my said invention of the new system of construction, and the principles of operation produced in the practice and management of the above-mentioned marine, fort, and field artillery, are ascertained and described conformable to the following maxims and explanations herein and hereafter expressed; that is to say: First; the cannon or gun carriage is reduced by construction to occupy the least possible space, and consequently to present the least surface to the action of either the direct, oblique, or flank fire of the enemy. Secondly; for the security of the gun-carriage in time of action, when employed for sea service on-board of line

of battle ships or other ships of war, or as marine or fort artillery, it is covered from the fire of the enemy by the gun and fulcrum, and is by construction rendered permanent, and always true to the centre of the port or embrasure. Thirdly; the recoil or re-action of either light or heavy cannon is by the operations of this system completely performed within the carriage itself, and can be diminished or increased at pleasure. Fourthly; the horizontal range, and the elevation or depression of cannon in the time of action, is correctly performed with an uniform motion, and with the greatest facility and security to those employed in the operations of this artillery. Fifthly; the cannon or gun carriage containing in itself by the geometrical design of its construction, the least quantity of materials of which it can be made, and the strongest fortification against the effects of either shot or shells. It is, therefore, my intention to render this system or the same artillery at once subservient, and universally applicable and convenient, with the utmost dispatch, to the three great operations of national warfare; that is, for either marine, fort, or field service.

Having thus specified five of the principal maxims observed in the construction, and effectually performed in the practice of this artillery, I here give only such description and explanations of the nature of my invention as are consistent with my duty in the promotion of public security, and the designs or proper objects of military mechanics. The system, therefore, of construction in mounting either light or heavy cannon for marine or fort service will be found to consist in the following parts; that is to say: First; the body of the cannon or gun-carriage. This may be made of wood, iron, composition of metal, or other fit material. Secondly; the fulcrum; which I make either of cast-iron, or composition, or other fit material;

terial; and which supports the piece of ordnance or cannon by its trunnions upon the carriage, either by a single cylinder, or by two parallel cylinders in a horizontal position upon iron axles. Thirdly; the train-bar and cylinder, with the gun-screws and bed of the cascable, which in time of action elevate or depress the breech of the cannon, or, in other words, determine the position of the gun's axis to the plane of the horizon. Fourthly; the recoil-chain, with its fore roller, chain, staple, and butt-pinion, fixed on iron axles in the front and butt of the carriage. Fifthly; the bolster or head-bearing, and the legs which are united and combined in construction by the tie or span iron parallel to the base of the carriage. Sixthly; the centre pin and fore staple, which is fixed by strong bolts to the lower sill of the port or embrasure. Seventhly; the train-post and swifter, by which one man only is enabled to give the heaviest artillery or piece of ordnance its horizontal range with a steady uniform motion, and to sustain it with the greatest ease in any assigned position, either upon the deck of a line of battle ship or other ship of war, or on the platform of a battery in time of action.

In my exemplification of those parts in construction, I here limit myself to the specification of the system as applied to the piece of heavy ordnance already proved and established by experimental practice, being a thirty-two pounder, ten feet seven inches four lines in length, twenty-one inches nine lines diameter in the breech, and weighing 6328 lbs. avoirdupois. The body of the carriage for this piece of ordnance I have made, and consists of but one piece of elm, containing but 13.5 cubic feet of timber: its form in the vertical plane or section being a variable figure, consisting of a right line and a curve, the curve rising from the right line to the level of the

gun's axis in the plane of the horizon, and its plan being a parallelogram, terminated at each end, or at the front and butt of the carriage by semi-circular arches: in its dimensions, its length from front to butt upon the base line being equal to that of the cannon, its extreme breadth equal to the diameter of the breech, and its thickness to that of the metal under the chamber at the breech. From the centre of the front, or guard-plate of the carriage, to the point of contact with the curve, I have denominated the chase-level or plane of the carriage; and from this point of contact (called the train point) to the centre of the butt, I have named the train of the carriage. This distinction of parts in the body of the carriage I have found necessary, as being directly connected with the operations and effects of the artillery in action. From the diameter of the front arch to that of the butt in the middle of the plane and base of the carriage is cut a regular groove, two inches deep and four inches wide, with a mortise at each end, wherein the front roller and butt pinions are fixed on their axles, and over which the flat or recoil chain traverses alternately in time of action; the forward motion for running the gun out by centre handspikes applied to the axle of the butt-pinion, the backward motion for counteracting the recoil. In the upper and lower plane of the body of the carriage are let in flush and even with the surface, and fixed by eight stock or screw bolts with counter-sunk nuts, the chase plate and base plate of the carriage, consisting of thin slips of plate-iron, the upper plate about half an inch thick, and divided into three parallel slips, the middle slip six inches in breadth, and the side slips three inches in breadth, and extending the whole length of the body, and united at the front and butt by similar plates, corresponding with the semi-circular arches. In the

the middle of the upper or chase plate is made a parallel groove or opening of two inches wide, extending from within nine inches of the front roller to the same distance of the butt-pinion; the side slips of the chase plate being united and combined with the middle slip by four stays on each side at equal distances. The two side slips of the base-plate, being three quarters of an inch thick and three inches in breadth, are united by four cross braces, of equal strength, corresponding with the four stays in the chase plate, and through which the above-mentioned stock-bolts are passed flush with the upper and lower surface of the body, forming at once two solid and parallel planes of the greatest strength and resistance. Upon the upper plane or chase level of the carriage is placed the fulcrum, which is denominated either a single or double fulcrum; as it is constructed either with a single cylinder and axle, or with two parallel cylinders and axles, passing through the lower frame or sills of the fulcrum, the former being for the mounting of light cannon, such as from the twenty-four pounder downwards, and the latter for heavy cannon, such as from the thirty-two pounder upwards. The fulcrum is also considered as constructed to a fixed or invariable radius, or to a variable or indefinite radius; the former always bearing the centre of the trunnions to a given height above the chase level of the carriage, the latter admitting of every degree and minute of elevation from the plane of the horizon to the angle of forty-five degrees and upwards; the parts in construction of the single fulcrum consisting of the two side standards, whereon the trunnions rest in semi-circular arches, and are therein secured by the trunnion-hasps or cap-squares; these side standards being united or combined by a strong round transom, and by the wrought iron axle passing through the lower sill or frame

frame of the fulcrum. On this axle the chase cylinder turns and acts upon the plane or chase level of the carriage. The sides of the lower sill or frame of the standards being rabbetted, so as to project in upon the chase one inch; and descending one inch below its level, forms a wide groove, corresponding with the parallel sides of the chase plate, and hereby directing the fulcrum in its alternate motion in a right line upon the plane of the chase. To the lower frame of the fulcrum are also attached the setting screws, one on each side of the body, with a vertical cylinder on each screw-bolt for acting on the sides of the carriage: these setting screws being tied together, or united by the base plate of the fulcrum, lying below the cylinders across and under the base of the carriage; the sill or frame of the fulcrum being at right angles to the side standards, in the after-part of which is fixed a small axle, passing through the train-rings and chain-staple parallel to the axle of the chase cylinder; the staple being fixed by three or four rounds of the recoil-chain passing through the lower part of it under the chase plate; by this means the fulcrum and cannon are completely secured on the carriage, but at the same time left perfectly free to the direction of its motions, as far as the gunner or military engineer may consider necessary for his purpose. To the train-rings placed on each side of the chain-staple, on the same axis is fixed the fore end of the train-bar by a small bolt and forelock; at the after-end of this bar, which lies directly under the cincture and ogee of the cascable (when the axis of the piece lies in the plane of the horizon), are formed the bearings or eyes, through which the axle of the train-cylinder is passed parallel to the plane of the chase in an horizontal position, and on which the cylinder and gun-screws are placed. Upon the gun-screws are brought on the bed

of

of the cascable, in the mortices of which at each end are the screw pinions, through which the gun-screws pass in a perpendicular position on each side of the cincture. Through the back part of the bed, under the cascable, is fixed the perpendicular screw that drives the pinions, and, by means of a winch handle, gives the uniform vertical motion required for the elevation and depression of the gun's axis.

Having above described the form and construction of the invariable single fulcrum and train, that of the invariable double fulcrum may be now easily conceived by any engineer or mechanic, as the only real difference consists in the former acting with a single cylinder, and the latter with two parallel cylinders upon the chase plane of the carriage; the cylinder on the after-axle being divided into two parts, in order to give place to the train-rings (if necessary) and the chain-staple upon the same axle. The side standards of the double fulcrum may be indefinitely varied as to their form. That figure which presents the least surface with the greatest strength and curvature is the best in time of real action for rendering the shot of the enemy reflective and ineffectual. And I here observe, as one general maxim in construction, that all repellent or acute angles which may be cut by either round or grape shot are to be carefully avoided as much as possible in the configuration of the parts of this system. The side standards of the double fulcrum used in mounting the piece of heavy ordnance above-mentioned, are formed by describing the arch of a semi-circle upon the lower sill or frame, and an inverted arch of a small circle from the centre of the trunnion upon the periphery of the lower arch, the extreme diameter of which is eighteen inches, and that of the inverted arch, where the centres of the trunnions are placed parallel to the chase,

sixteen

sixteen inches. The height of the centre of each trunnion from the chase level is here equal to the diameter of the plat-band of the breech; and this height is called the radius of the fulcrum, which constitutes the sine of the angle of elevation to the gun's axis, and may be calculated to produce the angle of fifteen degrees. The side standards of this fulcrum being rounded off in every position, and united or combined by the strong segment of a large cylinder, twelve inches diameter, in place of a round transom. In the lower frame or sills are four setting screw-bolts, two on each side of the body, with their vertical cylinders, and with the base-plate below the cylinders, as described in the single fulcrum.

Having thus particularly explained the construction of the fixed or invariable fulcrums, both single and double, I shall now briefly describe the nature of that which produces the variable radius, and consequently any degree of elevation to the gun's axis from the plane of the horizon to the angle of forty-five degrees and upwards. This fulcrum, whether single or double, consists of two parts; first, the lower frame or sills, which contain the chase, cylinders, and axles, with the train and with the setting screws as above explained; secondly, the side standards united by a round transom, and forming two parallel triangles, the base of each resting or supported on the sides of the lower sills, which is in length equal to the base of the triangles; the perpendicular of each triangle or side standard being directly under the trunnions, and sufficient to admit in the first instance (by the train) of an elevation from ten degrees to fifteen degrees of the gun's axis, with the base resting upon the lower sills; the inclined plane of each triangle being towards the breech, and meeting the base on the after-part of the sills, where a strong joint is made as a centre upon which the fulcrum

is

is raised to produce the greatest angle of elevation; the front of each standard or triangle being the segment or arch of a circle, described by a radius from the above joint or centre, with the lower part of each segment passing through a mortice on each side of the carriage in the fore part of the sills. In this mortice, on each side behind the segments, are fixed two strong nuts or pinions on an axle parallel to the chase cylinders, which acting on the inside of the segments, from the axle being turned by two men with the centre handspikes, raises the gun and fulcrum, which at every five degrees of elevation is fixed by a strong iron lever or stopper passing into the segments from the sill on each side. The fifth part in construction being the bolster or head-bearing, combined by the tie or span iron with the legs; the bolster being a ring or circle of cast-iron placed on the plane of the fore staple with four friction balls; the diameter of this circle being nearly equal to the front of the carriage, which it bears, and turns with it round the centre pin. Below this is the fore staple, being an oblong plate of cast-iron, three feet in length, sixteen inches in breadth, and one inch thick, rounded at the end, having an open groove, two feet nine inches in length, and three inches wide, through which the centre pin passes from the deck or platform through the head of the carriage. In the lower part of the fore staple are the holes through which the staple-bolt passes that fixes the carriage by the centre pin at any given distance from the sill of the port or embrasure.

Sixthly; the bar of the fore staple being strongly secured by three iron bolts through the sill of the port, and its step at the other end fixed by a bolt to the deck or platform; by this means the gun and carriage are

firmly preserved in every position, and at all times correctly true to the centre of the port, or to the direct line of fire. From the bolster or head-bearing extends parallel to the base the tie or span iron, one inch in diameter, which, dividing into two parts, forms a triangle with the foot bar of the legs, about eighteen inches wide and the same in length, and to which it is fixed by two screw nuts on the outside of the bar; the legs of the carriage being two strong inverted segments of a circle, made of cast iron, standing inclined to each other, and perpendicular to the base of the carriage, with the circular or box foot of each leg about four feet apart; the upper end of each leg morticed into the butt of the carriage with a flaunch, so as to support the whole in a correct horizontal position. Under the foot of each leg I have at present fixed two metal cylinders upon a horizontal axle; which construction I recommend as best adapted for naval service, where considerable friction is frequently necessary; but for fort service it is my intention to make use of cannon-shot, which will increase the velocity of the carriage in its horizontal range.

Seventhly, and lastly; for the purpose of producing the uniform horizontal motion or range of this system of artillery upon the deck of a line of battle ship or other ship of war, or on the platform of a battery, I here apply the easiest and most powerful means possible; which is, that of a swifter, being a piece of five-inch rope fastened to the centre of the bar and to each foot, and passing through a snatch-block, at a proper distance on each side of the carriage; and with a single block at each end of the swifter, I make use of a piece of three-inch rope, of sufficient length, the end of which is fixed to the train-post, and the other immediately behind it to a staple in the

the deck or platform. This train-post being fixed in a vertical position in the rear of the gun directly opposite the centre of the port or embrasure, one man brings the gun into position with the greatest facility.

Having here explained the construction and application of this system of artillery as employed in marine and fort service, it is hereby my intention, under the protection of the said letters patent, to construct, and bring into practice, such a set of wheels as shall receive the above carriage with its ordnance already mounted in manner above described, so that the same artillery may at any time, or on any occasion of necessity, be taken either from the deck of a ship of war or from the platform of a battery, and brought to action in the service of the field.

In witness whereof, &c.

Specification of the Patent granted to JOHN HOULDITCH, *of Long Acre, in the County of Middlesex, Coachmaker; for certain Improvements in the Construction of Four-wheeled Carriages of different Descriptions.*

With a Plate.

Dated March 7, 1807.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Houlditch do hereby declare that the nature of my said invention, and the manner in which the same is to be performed, are particularly described and ascertained as follows; that is to say: in every description of crane-necked carriages, instead of fixing or

connecting the crane to or with the set of wheels in the usual manner; I interpose the springs respectively between the axles or framings, or other apparatus to which the wheels are usually attached, and the cranes hereinafter described. And farther, that I do by bolts or screws, or keyed pieces or other well-known means, fix and secure the body of the carriage to the said cranes, so that the said body may safely and firmly remain connected and in its place so long as may be required; but that it shall and may be practicable to take off the said body, and substitute any other body as occasion may require.

And I do farther declare, that the said cranes, to the number of two or more, are to be placed and disposed as hereinbefore specified in the longitudinal direction parallel to each other, or nearly so; and that I do make use of two such cranes in preference to any other number, and do place the same at such a distance asunder, as that the body may be well and effectually supported or sustained by the same; and in some cases, or with some descriptions of carriages, I make the said cranes each of two pieces, to be screwed or otherwise secured to the body of the carriage, without joining each piece together in the middle.

And I do farther declare, that the springs may be made of any convenient figure or structure, and that the number and disposition or placing of the same may be governed by the judgment of the maker, provided only that the said figure, structure, number, and disposition or placing, shall be such as shall admit and allow of the carriage being drawn along or moved, and of the actions and re-actions being communicated through, and by means of such springs, without any inconvenient derangement of the relative situations of any of the several parts

of

Fig. 1.

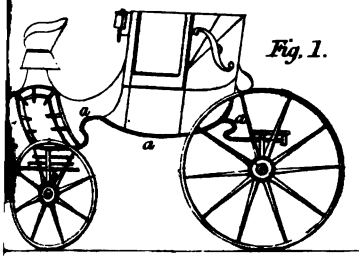


Fig. 1.

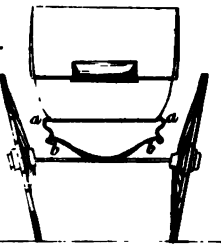


Fig. 2.

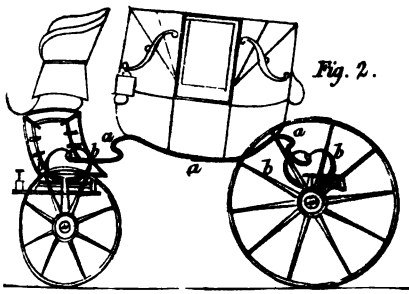


Fig. 2.

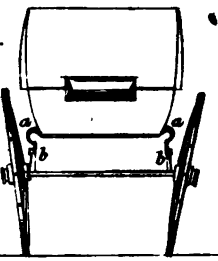


Fig. 3.

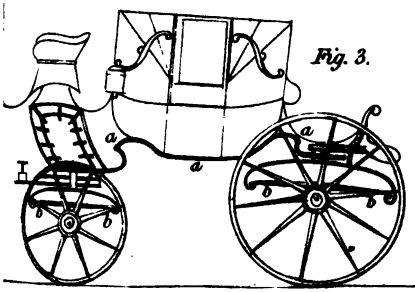


Fig. 5.

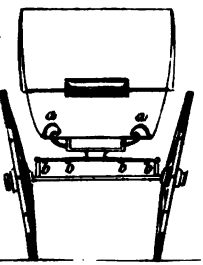


Fig. 4.

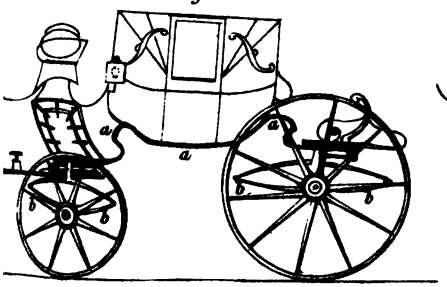
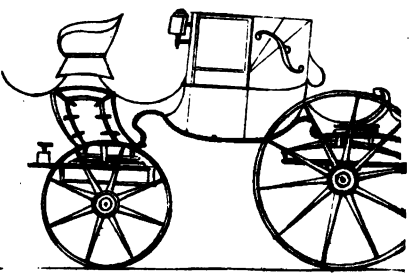


Fig. 5.



of the whole machine; and accordingly, that the said springs may consist either of transverse single bows with other bows fixed horizontally on the ends of, and at right angles to the same, such as have been commonly used and applied in long coaches or otherwise; and accordingly, that the said springs may consist each of two bows joined at the ends and disposed longitudinally, such as have been commonly used and applied in curricles, gigs, and other carriages, under the denomination of grasshopper springs. And that I do give the preference to the said horizontal or grasshopper springs in the construction of carriages, in and to which I do introduce and apply my said improvements.

And, lastly, in order the more fully to illustrate my said invention, I have hereunto annexed several drawings (see Plate VII.) numbered 1, 2, 3, 4 and 5, in all which the letters *a a* represent the cranes upon which the body is placed, and the letters *b b* represent the springs upon and to which the cranes rest and are fixed; and the other parts not having any particular relation to my said invention may be understood without farther reference.

And I do declare, that my said improvements are capable of being applied in a variety of other forms, agreeably to these presents, which will readily occur to any competent workman who shall have perused the same.

In witness whereof, &c.

Specification

Specification of the Patent granted to WILLIAM SPEER, *of the City of Dublin, Esquire, lately residing in Crown-street, in the City of Westminster, and still residing in the said City of Westminster; for a new Art, Method, or Process of purifying, refining, and otherwise improving Fish Oils and other Oils, and converting and applying to Use the unrefined Parts thereof.*

Dated December 13, 1806.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said William Speer do hereby describe and ascertain the nature of my said invention, and the manner in which the same is to be performed, as follows; that is to say: the nature of my said invention is in part expressed in the general description thereof, contained in the said recited letters patent; that is to say: A new art, method, or process of purifying, refining, and otherwise improving fish oils and other oils, and converting and applying to use the unrefined parts thereof; which unrefined parts are the same as the grounds, deposit, or residue, mentioned in the subsequent parts of this specification; and the general nature of the said invention may be farther understood from its being applicable to all animal oils and expressed vegetable oils, for the improvement thereof respectively, with more or less effect in proportion to the quantity or degree of impurity contained in such oils, before the same are subjected to the said art, method, or process; the principle of the said invention being to separate the impurities from the oil, and thereby improve the qualities thereof for burning and other uses, and to apply the substance of the said impurities to such uses as the same are fit for, as hereinafter stated. And the manner of performing the said invention is as follows: I add

add to the oil required to be refined a quantity of a solution or infusion of tannin, which I obtain from some substance or matter containing tannin as one of its constituent principles, such as the bark of oak or of alder, chesnut, birch, willow, or elm, or the root of tormentil *(tormentilla officinalis)* or other sorts of bark, roots, wood, or vegetables, which contain tannin or shumach, gall-nuts, Japan earth or catechu, or else I use artificial tannin prepared from various minerals and vegetable matters, by some or one of the processes described and explained by Charles Hatchet, esq. in the Philosophical Transactions of the Royal Society; or more generally speaking, I use some matter or substance, or combination of matters or substances, capable of being employed in the tanning of leather, and of which the solution, infusion, or decoction will coagulate a solution of animal glue or gelatine, these being the tests of such matter or substance being capable of, or fit for, purifying oils according to my invention. But the several before-mentioned substances not being all of them equally economical or fit for the purpose intended, nor equally easy to be procured in sufficient quantities, I therefore in practice prefer the bark of oak for making the solution or infusion, by means of which the refinement of the oil is to be effected. In doing this, I take a quantity of soft water equal to that of the oil required to be refined, in which I infuse for a considerable time (one or more day or days) about a tenth part of its weight of oak bark chopped or ground small; and during the time of infusion, I frequently agitate the same for the purpose of accelerating the solution; and finally, I rack off the clear infusion into another vessel. Then mixing in equal quantities the oil and infusion in a copper boiler, I apply heat thereto until the mixture boils, agitating the said mixture violently from the beginning of the application

tion of heat as aforesaid, not only until the boiling degree of heat is acquired, but also for some time afterwards, until I judge the mixture or combination of the oil and infusion sufficiently effected: towards producing which effect, I employ a machine or instrument in the nature of a churn or agitator, which may be variously formed, and in various ways applied, according to circumstances, at the will of the operator. The necessary period of agitation must depend also upon circumstances, such as the quality of the oil to be refined, the degree of violence of the agitation, and the heat of the mixture; in which latter point, though I use and recommend boiling heat, I do not describe that degree or any degree of heat as being absolutely essential, by reason that the general purpose may be effected whilst the mixture is cold, provided sufficient agitation by mechanical means be employed; agitation of some sort being absolutely necessary to effect the combination or mixture. I recommend also, not as necessary but as contributing to the beneficial result of the process, that during the boiling and agitation, a portion of cold water capable of considerably lowering the temperature be poured in gradually. This may be done at the end of a quarter of an hour (more or less), continuing the boiling and agitation afterwards for another quarter of an hour or half an hour (more or less). When I conceive the mixture to be sufficiently agitated, I run it off into another vessel, which I call the settling vessel, where I suffer it to subside or settle until the oil, being separated from the grounds and from the tannin liquor and water, becomes bright, at which time the unrefined parts will appear at the bottom of the oil, and upon the surface of the tannin liquor and water (that is between both). After which I rack or draw off the oil into other vessels for use or sale. If the oil is not sufficiently pure, after having undergone the above described

described process, I repeat it with greater or less quantities of the tannin infusion, and with more or less agitation and heat, as the case may require. And be it observed, that though I have for the sake of example mentioned certain quanties of oak bark and water to be used, proportioned to the oil to be refined, yet other quantities may and do answer the purpose; the quantities depending upon the quality of the oil to be refined, and other circumstances, which can only be judged of from experience, and by the sagacity of the operator. But with common whale or seal oil and good oak bark, the quantities specified above will produce the desired effect; and though I have recommended oak bark for its comparative cheapness and the facility of procuring it in large quanties, there are several of the above-mentioned substances, particularly the catechu, gall-nut, and shumach, which contain more tannin, and therefore might operate better or more expeditiously than oak bark.

And it is farther to be noted, that the quantities of the water employed to make the infusion of tannin, and the quantity of the tannin substance, are not determinate respectively, but mutually admit of variations, and that infusions in warm water or even decoctions may be used, though I prefer the cold infusion. I recommend towards the farther purification of the oil, after it has been separated from the grounds, that it should be again agitated for a considerable time in warm or hot water, or a weak tannin infusion also warm or hot, and then suffered to settle again, when a farther deposit will commonly take place, from which the clear oil must be racked or drawn off as before. In regard to the use to be made of the grounds, deposit, or unrefined parts of the oil, it is to be observed, that during the process of agitation, the particles of the tannin, by a chemical attraction, unite with

the gelatinous or mucilaginous matters contained in the oil, according to the respective natures thereof, and lay hold of or entangle the other impurities, whereby a viscous matter is formed, which is no longer soluble in cold water, and which, being heavier than pure oil, subsides to the bottom thereof, and, being lighter than water, swims upon the surface of the tannin infusion; that is to say, between both as above-mentioned.

Of the said grounds, deposit, or unrefined parts, when proceeding from fish oils or other animal oils, I make cement, by mixing the same with quick-lime or gypsum, and by the like mixture I make plaster or stucco. And I also employ the said grounds, deposit, or unrefined parts, towards making paints and varnishes for various purposes, using therewith, in the composition of such paints or varnishes, proper colouring or other matters adapted to the making of paints and varnishes respectively. Also, by using the said grounds, deposit, or unrefined parts, instead of linseed oil, I make putty, adding the other ingredients usual and fit for that purpose. And the said grounds, deposit, or unrefined parts, being insoluble in water, I employ the same as an ingredient, with others, in the making of blacking for leather, towards rendering the same capable of resisting the penetration of water; and this insolubility in water makes the said grounds, deposit, or unrefined parts, peculiarly applicable to the several purposes above enumerated; but the same existing in the mucilaginous parts of vegetable oils in a much less degree than in the gelatinous parts of fish oils, I prefer the use of the latter, though the grounds, deposit, or residue of vegetable oils, may be used with some effect in all or any of the above-described processes.

In witness whereof, &c.

Specification

Specification of the Patent granted to ALLAN POLLOCK, *of Paisley, in North Britain, Merchant; for a Stove on a new Construction, and various Improvements applicable to Stoves, Grates, and Fire-places.* Dated June 11, 1807.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Allan Pollock do hereby declare that the nature of my said invention, and the manner in which the same is to be performed, are particularly described and ascertained as follows; that is to say: in the drawing hereunto annexed, Fig. 1 (Plate VIII.) represents a perspective view of my said stove in one of the various forms in which the same may be constructed; and Fig. 2 represents the same by a vertical section, shewing the interior parts in their relative situations; and the Figs. 3, 4, 5, 6, 7 and 8, shew several of the same parts detached and separate. In the lower compartment of the said stove is placed the fire-place or grate, set in or surrounded with brick or stone, or other material of the like nature, as represented by the parts of the said drawing which are coloured yellow *; and behind, or if thought fit on any or either or all the sides except that in which the doors are made, I dispose and fix a second back or exterior part of iron, which, along with piece A C, Fig. 4, in which a set of edge bars or shelves are cast or fixed, doth afford a winding passage, through which air being admitted at the lower part from without, by means of an aperture or apertures left for that purpose, becomes heated by contact with the stove to a suitable temperature, but cannot be decomposed or subjected to any chemical change, because the interposed mass of brick or fire stone, or other materials of like na-

* The colouring is necessarily omitted in the plate.

ture, prevent the iron or metallic parts from being too strongly heated; and the said heated air ascends from the said winding passage into the pipe *w w*, and thence into the apartment through suitable openings in the vase or other ornamental piece at top. The space between I the grate, and R the upper part of the fire-place, is partly closed by a covering or piece represented and denoted by the same letter R in the Figs. 5, 6. In Fig. 5, the piece R is surmounted by other similar pieces S and T, more or less in number as may be required, which are fixed thereto in the manner there shewn. When the said compound piece, Fig. 5, is duly placed in the upper part of the stove, as represented in Fig. 2, the smoke and impure or decomposed air from the fire is made to ascend by a circuitous or helical course, through the several openings where its heat is communicated to the pipe W W, and to the body of the stove previous to its escape, which is permitted through the chimney.

And I do farther declare, that in order the more effectually to prevent any decomposition or chemical change from being effected at the inner surface of the said pipe W W, or at any other of the surfaces at which air is intended to be heated and introduced into apartments; it is expedient and of importance that the said surfaces should possess a hard and glassy coating, for which purpose I do expressly add such a proportion of lime or other fit material to the sand or loam to be made use of in forming my moulds, cores, or other receptacles or pieces in or upon which the metal is to be cast, as shall render the said sand or loam partially, or to such a degree fusible, that the action of the heat from the fluid and ignited metal convert a certain portion of the said sand or loam into a glassy coating, adhering to and defending the face thereof from such decomposition or chemical change. And farther, that as to the nature and pro-

Fig. 10.

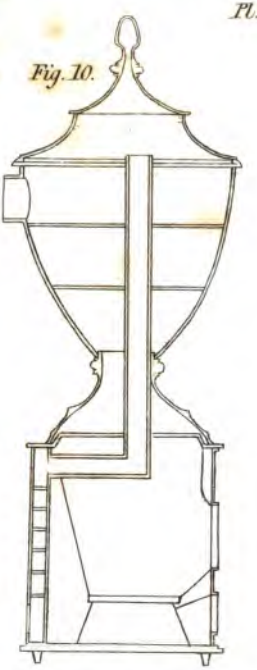
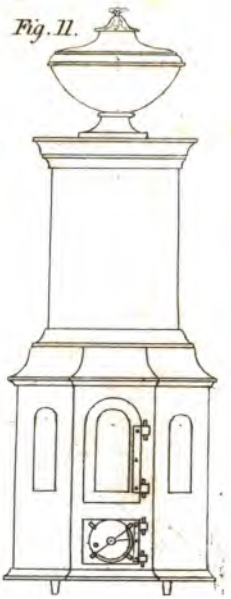


Fig. 11.



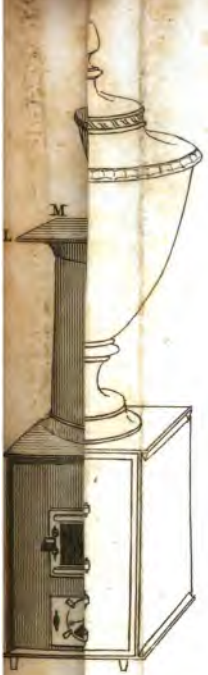


Fig. 13.

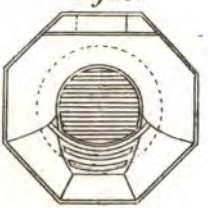


Fig. 12.

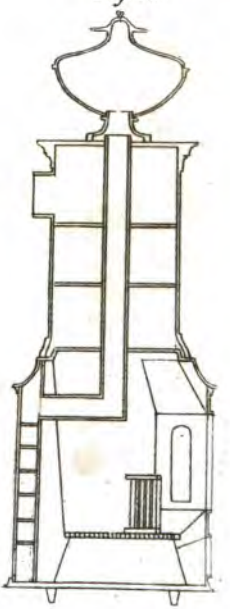
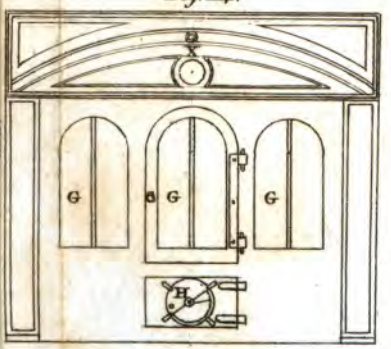


Fig. 14.



proportion of lime or other fit materials so to be added, I do declare that the same will require to be varied according to the nature and component part of the said sand or loam, and may be determined in each particular case by a few trials upon principles already well known to chemists and others.

Figs. 9 and 10, and Figs. 11 and 12, represent other forms of my said stove, which is capable of great variations in its figure, and may, if required, be made in any or all the parts thereof of earthy materials, such as natural or artificial stone, pottery, or the like, instead of using metal; and in these as well as in all other constructions, and in such cases as it may be desired, that the fire should be seen without opening the doors or other apertures of communications between the apartment and the fire-place, I do close or glaze the said doors or apertures, or any or all of them, with the material called Talc, or Muscovy Talc, set, fixed or secured therein in a workman-like manner.

And lastly, I do apply and use to and with other stoves, grates, and fire-places, as improvements in the same, my method of interposing brick or fire-stone, or any other material of the like nature, between the fire-place and a metallic channel or flue for heating air; and also my method of coating the metal with a glassy covering, and also my method of admitting the fire to be seen without opening the doors or apertures, by means of closing or glazing with talc as the said methods are hereinbefore described and explained; and in order that the same may be more clearly understood, I have shewn in Figs. 14, 15, 16, and 17, a common register stove having the said improvements, and being closed in front by a metallic plate, in which are seen the doors or apertures G, G, G, and H, the former of which, G, G, G, are glazed with talc. In witness whereof, &c.

OBSER-

OBSERVATIONS BY THE PATENTEE.

The Patentee begs leave to state the following as a few of the advantages to be derived from using his improved stoves.

They produce a complete circulation of air in every part of the room, without those currents of cold air which always exist in rooms warmed in the usual manner; a constant current of warm air entering the room from the external atmosphere, which is heated in its passage through the stove, while the cold air is continually passing off by the aperture in the ash-pit door.

The coating the parts of the stove through which the air passes to be heated, prevents the air from coming in contact with the iron, and preserves its purity.

They produce an equal temperature throughout the room, the thermometer seldom varying more than one degree in the different parts of the room.

Part of the front of the stove being made of transparent materials renders the fire visible, allowing both light and heat to pass into the room, and preserving the cheerful appearance of an open fire.

The lining the part of the stove wherein the fuel is placed with brick or fire-stone, prevents the surface of the stove from being over-heated, and renders them perfectly secure from all danger of fire.

They completely cure smoky chimnies, and prevent the dust arising from the ashes.

They save a great proportion of the fuel, and burn the fine or small coal nearly as well as the large.

One of the stoves may be seen at N° 33, Chancery-lane, where all orders will be carefully attended to.

On

On some Chemical Agencies of Electricity.

By HUMPHRY DAVY, *Esq. F. R. S. M. R. I. A.*

With a Plate.

From the PHILOSOPHICAL TRANSACTIONS of the ROYAL SOCIETY.

I. *Introduction.*

THE chemical effects produced by electricity have been for some time objects of philosophical attention; but the novelty of the phenomena, their want of analogy to known facts, and the apparent discordance of some of the results, have involved the enquiry in much obscurity.

An attempt to elucidate the subject will not, I hope, be considered by the Society as unfitted to the design of the Bakerian Lecture. I shall have to detail some minute (and I fear tedious) experiments; but they were absolutely essential to the investigation. I shall likewise, however, be able to offer some illustrations of appearances which hitherto have not been fully explained, and to point out some new properties of one of the most powerful and general of material agents.

II. *On the Changes produced by Electricity in Water.*

The appearance of acid and alkaline matter in water acted on by a current of electricity, at the opposite electrified metallic surfaces, was observed in the first chemical experiments made with the column of Volta *.

Mr. Cruickshank † supposed that the acid was the nitrous acid and the alkali ammonia. M. Desormes ‡ soon

* Nicholson's Journal, 4to, vol. IV. p. 183.

† Ibid. vol. IV. p. 261.

‡ Annales de Chimie, tom. XXXVII. p. 283.

after

after attempted to show by experiments, that muriatic acid and ammonia were the products; and M. Brugnatelli * asserted the formation of a new and peculiar substance, which he has thought proper to call the electric acid. The experiments said to be made in Italy, and in this country, on the production of muriate of soda, are recent †, and the discussions with regard to them still alive. As early as 1800. I had found that when separate portions of distilled water, filling two glass tubes connected by moist bladders, or any moist animal or vegetable substances, were submitted to the electrical action of the pile of Volta by means of gold wires, a nitro-muriatic solution of gold appeared in the tube containing the positive wire, or the wire transmitting the electricity, and a solution of soda in the opposite tube ‡; but I soon ascertained that the muriatic acid owed its appearance to the animal or vegetable matters employed; for when the same fibres of cotton were made use of in successive experiments, and washed after every process in a weak solution of nitric acid, the water in the apparatus containing them, though acted on for a great length of time with a very strong power, at last produced no effect upon solution of nitrate of silver.

In cases when I had procured much soda, the glass at its point of contact with the wire seemed considerably corroded; and I was confirmed in my idea of referring the production of the alkali principally to this source, by finding that no fixed saline matter could be obtained, by electrifying distilled water in a single agate cup from two

* Phil. Mag. vol. IX. p. 181.

† By M. Pacchioni, and Mr. Peele. Phil. Mag. vol. XXI. p. 279.

‡ I shewed the results of the experiment to Dr. Beddoes at this time; and mentioned the circumstance to Sir James Hall, Mr. Clayfield, and other friends in 1801.

points

points of platina connected with the Voltaic battery. Similar conclusions with regard to the appearance of the muriatic acid had been formed by the Galvanic Society of Paris, by Dr. Wollaston, who hit upon the happy expedient of connecting the tubes together by well washed asbestus; and by MM. Biot and Thenard *.

Mr. Sylvester, however, in a Paper published in Mr. Nicholson's Journal for last August, states, that though no fixed alkali or muriatic acid appears when a single vessel is employed; yet that they are both formed when two vessels are used. And to do away all objections with regard to vegetable substances or glass, he conducted his process in a vessel made of baked tobacco-pipe clay inserted in a crucible of platina. I have no doubt of the correctness of his results: but the conclusion appears objectionable. He conceives that he obtained fixed alkali, because the fluid after being heated and evaporated left a matter that tinged turmeric brown, which would have happened had it been lime, a substance that exists in considerable quantities in all pipe-clay; and even allowing the presence of fixed alkali, the materials employed for the manufacture of tobacco-pipes are not at all such as to exclude the combinations of this substance.

I resumed the enquiry; I procured small cylindrical cups of agate, of the capacity of about a quarter of a cubic inch each. They were boiled for some hours in distilled water, and a piece of very white and transparent amianthus that had been treated in the same way was made to connect them together; they were filled with distilled water, and exposed by means of two platina wires to a current of electricity, from 150 pairs of plates of copper and zinc 4 inches square, made active by means

* No. XL. Du Moniteur, 1806.

of solution of alum. After 48 hours the process was examined: paper tinged with litmus plunged into the tube containing the transmitting or positive wire was immediately strongly reddened. Paper coloured by turmeric introduced into the other tube had its colour much deepened; the acid matter gave a very slight degree of turbidness to solution of nitrate of silver. The fluid that affected turmeric retained this property after being strongly boiled; and it appeared more vivid as the quantity became reduced by evaporation; carbonate of ammonia was mixed with it, and the whole dried and exposed to a strong heat: a minute quantity of white matter remained, which, as far as my examination could go, had the properties of carbonate of soda. I compared it with similar minute portions of the pure carbonates of potash and soda. It was not so deliquescent as the former of these bodies, and it formed a salt with nitric acid, which, like nitrate of soda, soon attracted moisture from a damp atmosphere, and became fluid.

This result was unexpected, but it was far from convincing me that the substances which I had obtained were *generated*. In a similar process, with glass tubes, carried on exactly under the same circumstances, and for the same time, I obtained a quantity of alkali which must have been more than twenty times greater, but no traces of muriatic acid. There was much probability that the agate might contain some minute portion of saline matter, not easily detected by chemical analysis, either in combination, or intimate adhesion in its pores. To determine this, I repeated the experiment a second, a third, and a fourth time. In the second experiment turbidness was still produced by solution of nitrate of silver in the tube containing the acid, but it was less distinct; in the third process it was barely perceptible: and in the fourth the

the two fluids remained perfectly clear after the mixture. The quantity of alkaline matter diminished in every operation; and in the last process, though the battery had been kept in great activity for three days, the fluid possessed in a very slight degree only the power of acting on paper tinged with turmeric; but its alkaline property was very sensible to litmus paper slightly reddened, which is a much more delicate test: and after evaporation and the process by carbonate of ammonia, a barely perceptible quantity of fixed alkali was still left. The acid matter in the other tube was abundant; its taste was sour; it smelt like water over which large quantities of nitrous gas have been long kept; it did not affect solution of muriate of barytes; and a drop of it placed upon a polished plate of silver left after evaporation a black stain, precisely similar to that produced by extremely diluted nitrous acid.

After these results, I could no longer doubt that some saline matter existing in the agate tubes had been the source of the acid matter capable of precipitating nitrate of silver, and of much of the alkali. Four additional repetitions of the process, however, convinced me that there was likewise some other cause for the presence of this last substance; for it continued to appear to the last, in quantities sufficiently distinguishable, and apparently equal in every case. I had used every precaution; I had included the tubes in glass vessels out of the reach of the circulating air; all the acting materials had been repeatedly washed with distilled water; and no part of them in contact with the fluid had been touched by the fingers.

The only substance which I could now conceive capable of furnishing the fixed alkali was the *water itself*. This water appeared pure by the tests of nitrate of silver and muriate of barytes; but potash and soda, as is well known,

rise in small quantities in rapid distillations; and the New River water, which I made use of, contains animal and vegetable impurities, which it was easy to conceive might furnish neutral salts capable of being carried over in vivid ebullition.

To make the experiment in as refined a form as possible, I procured two hollow cones of pure gold containing about 25 grains of water each, they were filled with distilled water, connected together by a moistened piece of amianthus which had been used in the former experiments, and exposed to the action of a Voltaic battery of 100 pairs of plates of copper and zinc of 6 inches square, in which the fluid was a solution of alum and diluted sulphuric acid. In ten minutes the water in the negative tube had gained the power of giving a slight blue tint to litmus paper: and the water in the positive tube rendered it red. The process was continued for 14 hours; the acid increased in quantity during the whole time, and the water became at last very sour to the taste. The alkaline properties of the fluid in the other tube, on the contrary, remained stationary, and at the end of the time, it did not act upon litmus or turmeric paper more than in the first trial: the effect was less vivid after it had been strongly heated for a minute; but evaporation and the usual process proved that *some* fixed alkali was present. The acid, as far its properties were examined, agreed with pure nitrous acid, having an excess of nitrous gas.

I *repeated* the experiment, and carried on the process for three days; at the end of which time the water in the tube was decomposed and evaporated to more than one half of its original quantity; the acid was strong, but the alkali in as minute a portion as in the last experiment. It acted indeed rather more vividly on the tests, on account of the greater diminution of the fluid, but presented the same results after being heated.

It

It was now impossible to doubt that the water contained some substance in very minute quantities, capable of causing the appearance of fixed alkali, but which was soon exhausted; and the question that immediately presented itself was, is this substance saline matter carried over in distillation? or is it nitrogen gas which exists in minute portions in all water that has been exposed to air, and which, if an element of the fixed alkali, would under the circumstances of the experiment have been soon exhausted, whilst its absorption from the atmosphere would be impeded by the saturation of the water with hydrogen?

I was much more inclined to the former than to the latter supposition. I evaporated a quart of the distilled water that I had used, very slowly at a heat below 140° Fahrenheit, in a silver still: a solid matter remained, equal to $\frac{7}{10}$ of a grain; this matter had a saline but metallic taste, and was deliquescent when exposed to air: I could not obtain from it regular crystals; it did not affect turmeric or litmus, but a part of it, after being heated red, in a silver crucible, exhibited strong alkaline properties. It was not possible to make a minute analysis of so small a quantity, but it appeared to me to be principally a mixture of nitrate of soda and nitrate of lead; and the metallic substance, it is most likely, was furnished by the condensing tube of the common still.

The existence of saline matter in the distilled water being thus distinct, it was easy to determine its operation in the experiment. I filled the two gold cones with water in the usual manner; that negatively electrified, soon attained the maximum of its effect upon turmeric paper. I then introduced into a very minute portion of the substance obtained by the process of evaporation that has been just described; in less than two minutes its effects

effects were evident; and in five minutes the tint of the paper was changed to a bright brown.

I now conceived that by collecting the water obtained in the second process of slow distillation I should be able to carry on the experiment without *any* appearance of fixed alkali, and the trial proved that I was not mistaken.

Some of this water was introduced into the gold tubes, and the amianthus moistened by it.

After two hours the water in the negative tube produced no effect upon turmeric paper; it did produce an effect upon litmus, which it required great minuteness of observation to perceive; but it wholly lost the power by being heated strongly for two or three minutes, so there is every reason for supposing that it was owing to a small quantity of ammonia.

I made a similar experiment with a portion of the same water in the tubes of agate that had been so often used, and I had the pleasure of finding the results precisely the same.

To detail any more operations of this kind will be unnecessary; all the facts prove that the fixed alkali is not *generated*, but *evolved*, either from the solid materials employed, or from saline matter in the water.

I have made many experiments in vessels composed of different substances, with the water procured by very slow distillation: and in almost every instance some fixed alkali appeared.

In tubes of wax the alkaline matter was a mixture of soda and potash; and the acid matter a mixture of sulphuric, muriatic, and nitric acids.

In a tube of resin, the alkaline matter seemed to be principally potash.

A cube of Carrara marble of about an inch, having an aperture in its centre, was placed in a crucible of platina, which

which was filled as high as the upper surface of the cube with the purified water, the aperture was filled with the same fluid; the crucible was positively electrified by a strong Voltaic power, and a negatively electrified wire introduced into the aperture.

The water soon gained the property of affecting the tint of turmeric; and fixed alkali and lime were both obtained from it: and this effect took place in repeated experiments: the fixed alkali, however, diminished in quantity every time; and after eleven processes conducted from two to three hours each, disappeared altogether. The production of lime-water was uniform.

I made a solution of 500 grains of this marble in nitric acid; I decomposed the mixture by carbonate of ammonia, and I collected and evaporated the fluid part, and decomposed the nitrate of ammonia by heat. About ½ of a grain of fixed saline matter remained, which had soda for its base.

It was possible that the Carrara marble might have been recently exposed to sea-water; I therefore tried, in the same way, a piece of granular marble, which I had myself broken from a rock on one of the highest of the primitive mountains of Donegal. It afforded fixed alkali by the agency of negative electricity.

A piece of argillaceous schist from Cornwall, treated in the same manner, gave the same result; and serpentine from the Lizard, and grauwackè from North Wales, both afforded soda. It is probable that there are few stones that do not contain some minute portions of saline matter, which in many cases may be mechanically diffused through their substance: and it is not difficult to conceive the possibility of this, when we consider that all our common rocks and strata bear evident marks of having been anciently covered by the sea.

I was

I was now able to determine distinctly, that the soda procured in glass tubes came principally from the glass, as I had always supposed.

I used the two cones of gold with the purified water and the amianthus; the process was conducted as usual. After a quarter of an hour, the negatively electrified tube did not change the colour of turmeric. I introduced into the top of it a bit of glass; in a few minutes the fluid at the surface rendered the tint of the paper of a deep bright brown.

I had never made any experiments, in which acid matter having the properties of nitrous acid was not produced, and the longer the operation the greater was the quantity that appeared.

Volatile alkali likewise seemed to be always formed in very minute portions, during the first few minutes in the purified water in the gold cones, but the limit to its quantity was soon attained.

It was natural to account for both these appearances, from the combination of nascent oxygen and hydrogen respectively; with the nitrogen of the common air dissolved in the water: and Dr. Priestley's experiments on the absorption of gases by water (on this idea) would furnish an easy explanation of the causes of the constant production of the acid, and the limited production of the alkali: for hydrogen, during its solution in water, seems to expel nitrogen; whilst nitrogen and oxygen are capable of co-existing dissolved in that fluid *.

To render the investigation more complete, I introduced the two cones of gold with purified water under the receiver of an air-pump; the receiver was exhausted till it contained only $\frac{1}{64}$ of the original quantity of air;

* Priestley's Experiments and Observations, vol. I. p. 59.

and

and then, by means of a convenient apparatus, the tubes were connected with an active Voltaic pile of 50 pairs of plates of 4 inches square. The process was carried on for 18 hours, when the result was examined. The water in the negative tube produced no effect upon prepared litmus, but that in the positive tube gave it a barely perceptible tinge of red.

An incomparably greater quantity of acid would have been formed in a similar time in the atmosphere, and the small portion of nitrogen gas remaining in contact with the water, seemed adequate to the effect.

I repeated the experiment under more conclusive circumstances. I arranged the apparatus as before; I exhausted the receiver, and filled it with hydrogen gas from a convenient airholder; I made a second exhaustion, and again introduced hydrogen that had been carefully prepared. The process was conducted for 24 hours, and at the end of this time neither of the portions of the water altered in the slightest degree the tint of litmus.

It seems evident then that water, chemically pure, is decomposed by electricity into gaseous matter alone, into oxygen and hydrogen.

The cause of its decomposition, and of the other decompositions which have been mentioned, will be hereafter discussed.

III. *On the Agencies of Electricity in the Decomposition of various Compounds.*

The experiments that have been detailed on the production of alkali from glass, and on the decomposition of various saline compounds contained in animal and vegetable substances, offered some curious objects of enquiry.

It was evident, that in all changes in which acid and alkaline matter had been present, the acid matter col-

lected in the water round the positively electrified metallic surface; and the alkaline matter round the negatively electrified metallic surface; and this principle of action appeared immediately related to one of the first phænomena observed in the Voltaic pile, the decomposition of the muriate of soda attached to the pasteboard; and to many facts which have been since observed on the separation of the constituent parts of neutro-saline and metallic solutions, particularly those detailed by MM. Hisinger and Berzelius *.

The first experiments that I made immediately with respect to this subject were on the decomposition of solid bodies, insoluble, or difficultly soluble in water. From the effects of the electrical agency on glass, I expected that various earthy compounds would undergo change under similar circumstances; and the results of the trials were decided and satisfactory.

Two cups made of compact sulphate of lime, containing about 14 grain measures of water each, were connected together by fibrous sulphate of lime, which was moistened by pure water: the cups were filled with this fluid; platina wires from the Voltaic battery of 100 pairs of plates of six inches were introduced into them, so that the circuit of electricity was through the fibrous sulphate of lime. In five minutes the water in the cup connected with the positive wire became acid; that in the opposite cup strongly tinged turmeric. After an hour the fluids were accurately examined; when it was found that a pure and saturated solution of lime had been produced in the cup containing the negative wire, which was partially covered with a crust of lime; and that the other cup was filled with a moderately strong solution of sulphuric acid.

* Annales de Chemie, tom. LI. p. 167.

I pro-

I procured two cubical pieces of crystallized sulphate of strontites, of about an inch; a hole was drilled in each capable of containing about 8 grains of water: the cubes were plunged in pure water in a platina crucible; and the level of the fluid preserved a few lines below the surface of the cubes; two platina wires were introduced into the holes, which were filled with pure water. The disengagement of gas, when the wires were connected with the battery of 100, proved that the sulphate of strontites was sufficiently porous to form a proper conducting chain. The results were much longer in being obtained in this experiment than in the last: some time elapsed before a sensible effect could be perceived; but the termination was similar. In 30 hours the fluid in the cavity containing the negative wire had gained the property of precipitating solution of sulphate of potash; and the presence of sulphuric acid in the other cavity was evident from its effect upon solution of muriate of barytes.

I made an experiment upon fluate of lime under like circumstances; but the crystallized fluate not being equally permeable to moisture, the two cavities were connected by moist asbestus. This decomposition was likewise very slow; but in the course of two days a pretty strong solution of lime was obtained in one tube; and an acid fluid in the other, which precipitated acetite of lead, and left a spot upon the glass from which it had been evaporated.

Sulphate of barytes, as might be supposed, proved much more difficult of decomposition than either sulphate of strontites or fluate of lime. I had made four or five experiments upon it, with the same kind of apparatus that had been applied to the fluate of lime, before I was able to gain decided results. In the last process performed on this substance, two pieces of a large single crystal were hollowed by grinding, so as to contain about five grains

of water each: they were connected by moist asbestus, and constantly subjected during four days to the strong action of a battery of 150 pairs of plates of four inches square. As the water diminished, its place was supplied by new quantities. At the conclusion of the experiment the fluid on the positive side of the apparatus instantly reddened litmus, tasted very sour, and gave a distinct precipitate with a solution of muriate of barytes; the water on the other side deepened the tincture of turmeric; but did not render solution of sulphate of potash turbid. There was a small quantity of white crust, however, on the sides and the bottom of the cavity, and I conceived that this might be the barytes, which, during the extremely slow decomposition, would have combined with the carbonic acid of the atmosphere. To ascertain if this had been the case, I introduced into the cavity a drop of diluted muriatic acid; a slight effervescence appeared, and the fluid obtained occasioned a distinct white cloudiness in solution of sulphate of soda.

In all these cases the constituent parts of the bodies newly arranged by the effects of electricity existed in considerable quantities, and exposed on a large surface to its action. I had great reason to believe, however, from the trials with distilled water in different vessels, that very minute portions of acid and alkaline matter might be disengaged by this agency from solid combinations, principally consisting of the pure earths.

This part of the investigation was easily elucidated.

For a purpose of geological enquiry, which on a future occasion I shall have the honour of laying before the Society, I had made a careful analysis of a specimen of fine grained basalt from Port Rush in the county of Antrim, by means of fusion with boracic acid: it had afforded in 100 parts 3½ parts of soda, and nearly half a part

part of muriatic acid, with 15 parts of lime. This stone appeared to me very well fitted for the purpose of experiment: cavities were drilled in two pieces, properly shaped; they contained about 12 grains of water each; they were connected by moistened amianthus, and the process conducted as usual with a power of 50 pairs of plates. At the end of ten hours the result was examined with care. The fluid that had been positively electrified had the strong smell of oxymuriatic acid, and copiously precipitated nitrate of silver; the other portion of fluid affected turmeric, and left by evaporation a substance which seemed to be a mixture of lime and soda.

A part of a specimen of compact zeolite, from the Giant's Causeway, which by analysis had given 7 parts in 100 of soda, had a small cavity made in it; it was immerged in pure water in a crucible of platina, and electrified in the same manner as the cube of Carrara marble, mentioned in page 191. In less than two minutes the water in the cavity had gained the property of changing the colour of turmeric; and in half an hour the solution was disagreeably alkaline to the taste. The matter dissolved proved to be soda and lime.

Lepidolite, treated in the same way, gave potash.

A piece of vitreous lava, from Etna, gave alkaline matter, which seemed to be a mixture of soda, potash, and lime.

As in these trials the object was merely to ascertain the general fact of decomposition, the process was never conducted for a sufficient time to develope a quantity of alkaline matter capable of being conveniently weighed, and of course any loss of weight of the substance could not be determined.

I thought it right, however, to make one experiment of this kind, for the sake of removing every possibility of doubt

doubt on the source of the different products; and I selected for this purpose glass, as a substance apparently insoluble in water, and not likely to afford in any way erroneous results.

The balance that I employed was made for the Royal Institution, by Mr. Fidler, after the model of that belonging to the Royal Society: it turns readily with $\frac{1}{500}$ of a grain when loaded with 100 grains on each side; a glass tube with a platina wire attached, weighing 84 grains $\frac{56}{128}$ was connected with an agate cup, by amianthus; they were filled with purified water, and electrified by a power from 150 pairs of plates, in such a way that the platina in the glass tube was negative. The process was continued for 4 days, when the water was found alkaline. It gave by evaporation and exposure to a heat of about 400° Fahrenheit, soda mixed with a white powder insoluble in acids, the whole weight of which was $\frac{36}{128}$ of a grain. The glass tube carefully cleaned and dried weighed 84 grains, $\frac{37}{128}$. The difference between the loss of weight of the tube and the weight of the products in the water may be easily explained: some minute detached particles of amianthus were present, and the soda must have contained water, a substance which it is probably perfectly free from in glass.

Having obtained such results with regard to the disengagement of the saline parts of bodies insoluble in water, I made a number of experiments on soluble compounds; their decomposition was always much more rapid, and the phænomena perfectly distinct.

In these processes I employed the agate cups with platina wires, connected by amianthus moistened in pure water; the solutions were introduced into the cups, and the electrifying power applied from batteries of 50 pairs of plates, in the usual way.

A diluted

A diluted solution of sulphate of potash treated in this manner, produced in four hours at the negative wire a weak lixivium of potash; and a solution of sulphuric acid at the positive wire.

The phænomena were similar when sulphate of soda, nitrate of potash, nitrate of barytes, sulphate of ammonia, phosphate of soda, succinate oxalate, and benzoate of ammonia, and alum were used. The acids in a certain time collected in the tube containing the positive wire, and the alkalies and earths in that containing the negative wire.

Solutions of the muriatic salts, decomposed in the same way, uniformly gave oxymuriatic acid on the positive side.

When compatible mixtures of neutro-saline solutions containing the common mineral acids were used, the different acids and the different bases seemed to separate together in a mixed state, without any respect to the orders of affinity.

When metallic solutions were employed, metallic crystals or depositions were formed, as in common Galvanic experiments, on the negative wire, and oxyd was likewise deposited round it; and a great excess of acid was soon found in the opposite cup. With solutions of iron, zinc, and tin, this effect took place, as well as with the more oxydable metals: when muriate of iron was used, the black substance deposited upon the wire was magnetic, and dissolved with effervescence in muriatic acid; and when sulphate of zinc was used, a grey powder possessed of the metallic lustre, and likewise soluble with effervescence, appeared; and in all cases acid in excess was exhibited on the positive side.

Strong or saturated saline solutions, as might have been expected, afforded indications of the progress of decomposition

composition much more rapidly than weak ones; but the smallest proportion of neutro-saline matter seemed to be acted on with energy.

A very simple experiment demonstrates this last principle. If a piece of paper tinged with turmeric is plunged into pure water in a proper circuit, in contact with the negative point, the very minute quantity of saline compound contained in the paper, affords alkaline matter sufficient to give it instantly a brown tint near its point of contact: and acid in the same manner is immediately developed from litmus paper, at the positive surface.

I made several experiments, with the view of ascertaining whether, in the decompositions by electricity, the separation of the constituent parts was complete from the last portions of the compound; and whenever the results were distinct, this evidently appeared to be the case.

I shall describe one of the most conclusive of the experiments: a very weak solution of sulphate of potash, containing 20 parts water and one part saturated solution, at 64°, was electrified in the two agate cups by the power of 50 pairs of plates for three days: the connecting amianthus, which had been moistened with pure water, was removed, washed with pure water, and again applied, twice every day; by this precaution the presence of any neutral salt that might adhere to it, and disturb the results, was prevented. The alkali obtained in this process in the solution had the properties of pure potash; and when it had been saturated with nitric acid it gave no turbidness by mixture with solution of muriate of barytes: the acid matter exposed to a strong heat evaporated without leaving any residuum.

IV. *On*

IV. *On the Transfer of certain of the constituent Parts of Bodies by the Action of Electricity.*

M. Gautherot has stated *, that in a single Galvanic circle of zinc, silver, and water, in an active state, the oxyd of zinc formed is attracted by the silver †; and MM. Hisinger and Berzelius detail an account of an experiment, in which solution of muriate of lime being placed in the positive part of a siphon, electrified by wires from a Voltaic pile, and distilled water in the negative part, lime appeared in the distilled water.

These facts rendered it probable, that the saline elements evolved in decompositions by electricity were capable of being transferred from one electrified surface to another, according to their usual order of arrangement; but to demonstrate this clearly, new researches were wanting.

I connected one of the cups of sulphate of lime, mentioned page 194, with a cup of agate by asbestus; and, filling them with purified water, made the platina wire in the cup of sulphate of lime transmit the electricity from a power of 100: a wire in the agate cup received it. In about four hours a strong solution of lime was found in the agate cup, and sulphuric acid in the cup of sulphate of lime. By reversing the order, and carrying on the process for a similar time, the sulphuric acid appeared in the agate cup, and the solution of lime on the opposite side.

Many trials were made with other saline substances, with analogous results. When the compounds of the strong mineral acids with alkaline or alkaline-earthy bases were introduced into one tube of glass, distilled

* Annales de Chimie, vol. XXXIX. page 203.

† Ibid. vol. LI. page 171.

water connected by amianthus being in another tube, both connected by wires of platina in the Voltaic arrangement, the base always passed into the distilled water when it was negative, and the acid when it was positive.

The metals and the metallic oxyds passed towards the negative surface like the alkalies, and collected round it. In a case in which solution of nitrate of silver was used on the positive side, and distilled water on the negative, silver appeared on the whole of the transmitting amianthus, so as to cover it with a thin metallic film.

The time required for these transmissions (the quantity and intensity of the electricity, and other circumstances remaining the same) seemed to be in some proportion as the length of the intermediate volume of water. Thus when with the power of 100, sulphate of potash was on the negative side, and distilled water on the positive side, the distance between the wires being only an inch, sulphuric acid, in sufficient quantity to be very manifest, was found in the water in less than five minutes: but when the tubes were connected by an intermediate vessel of pure water, so as to make the circuit 8 inches, 14 hours were required to produce the same effect.

To ascertain whether the contact of the saline solution with a metallic surface was necessary for the decomposition and transfer, I introduced purified water into two glass tubes; a vessel containing solution of muriate of potash was connected with them respectively by amianthus; and the arrangement was made in such a way, that the level of both the portions of purified water was higher than the level of the saline solution.

In this case the saline matter was distant from each of the wires at least $\frac{2}{3}$ of an inch; yet alkaline matter soon appeared in one tube, and acid matter in the other: and

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in 16 hours moderately strong solutions of potash and of muriatic acid had been formed.

In this case of electrical transfer or attraction, the acid and alkaline matter seemed to be perfectly pure; and I am inclined to believe that this is uniformly the case in all experiments carefully made. One of the instances in which I conceived acid most likely to be present, was in the transfer of magnesia from sulphate of magnesia in the positive tube, to distilled water in the negative tube. I examined the case, taking care that the distilled water was never upon a lower level than the saline solution: the process was continued for some hours, till a considerable quantity of magnesia had appeared. The connecting amianthus was removed, and muriatic acid poured into the tube: the saturated solution did not precipitate solution of muriate of barytes.

I endeavoured to ascertain the progress of the transfer, and the course of the acid or alkaline matter in these decompositions, by using solutions of litmus and turmeric, and papers coloured by these substances; and these trials led to the knowledge of some singular and unexpected circumstances.

Two tubes, one containing distilled water, the other solution of sulphate of potash, were each connected by amianthus with a small ounce measure filled with distilled water tinged by litmus: the saline solution was negatively electrified; and as it was natural to suppose, that the sulphuric acid in passing through the water to the positive side would redden the litmus in its course, some slips of moistened paper tinged with litmus were placed above and below the pieces of amianthus, directly in the circuit. The progress of the experiment was minutely observed; the first effect of reddening took place immediately above the positive surface, where I had least expected it; the

red tint slowly diffused itself from the positive side to the middle of the vessel, but no redness appeared above the asbianthus, or about it, on the negative side, and though it had been constantly transmitting sulphuric acid, it remained unaffected to the last.

The order of the experiment was changed, and the saline solution placed on the positive side; a solution and papers tinged with turmeric being substituted for those tinged with litmus. The effect was precisely analogous; the turmeric became brown first, near the negative wire, and no change took place in the intermediate vessel near the positive wire.

In another process, the two glass tubes were filled with solution of muriate of soda, and the intermediate vessel with solution of sulphate of silver; paper tinged with turmeric was placed on the positive side, and paper tinged with litmus on the negative side; as soon as the electrical circuit was complete, soda began to appear in the negative tube, and oxymuriatic acid in the positive tube; and the alternate products were exhibited passing into the solution of sulphate of silver, the muriatic acid occasioning a dense heavy precipitate, and the soda a more diffused and a lighter one; but neither the turmeric transmitting the alkali, nor the litmus transmitting the acid, had their tints in the slightest degree altered.

TO BE CONCLUDED IN OUR NEXT.

REPORT

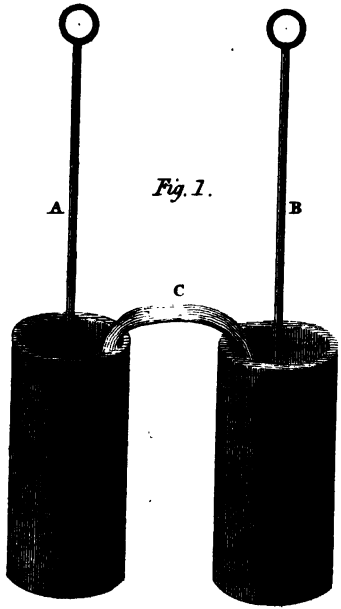

Fig. 1.

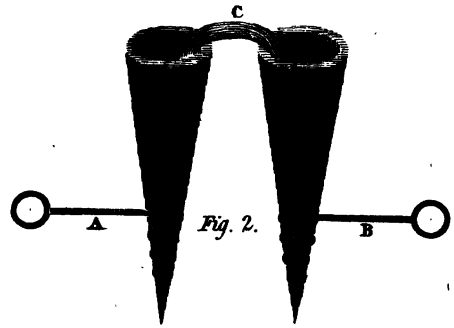

Fig. 2.

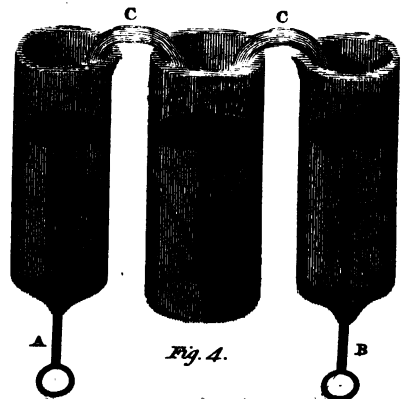

Fig. 4.

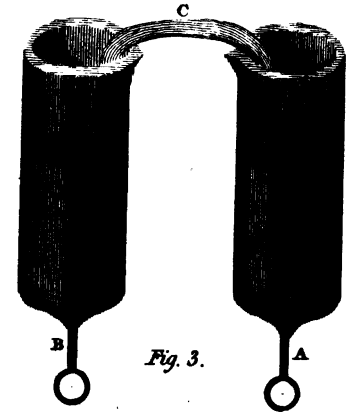

Fig. 3.

REPORT on the Sprinkling of Malt on the Floor, by Mr. JOHN CARR, *in obedience to an Order of the Commissioners of Excise.*

(Concluded from Page 121.)

Temperature of the Floors in Malting.

THERE is no one circumstance in the manufacturing of good Malt that merits so constant and careful an attention to the working Floors as this Temperature. There is a certain maximum of heat that is the best adapted to Malting, and with which the vegetation will proceed in the safest and most natural order; either above or below this temperature is a disadvantage, but an excess and fluctuation of heat are highly injurious in a Malt-house. In whatever way the floors are worked, the temperature will continue to rise in proportion to the time they lie undisturbed; and the only method of checking the rise is by turning them.

Moisture is the remote cause of all heat in vegetable substances, heaped together, and containing a farinaceous or starchy matter. This matter passes into a state of fermentation, attracts oxygen from the atmosphere, which in its fixation, parts with the latent heat it was before combined with, and this accumulating in the heap will frequently rise to inflammation. The heat of a dunghill, moist hay-rick, wet barley, and all other similar heaps of wet vegetable matter, originate in one and the same natural cause. In floors of Malt the heat is always in proportion to the quantum of moisture and repose of the floor.

The chief object in a well-regulated malt-house is not only to preserve the floors in one equable state of temperature from the cistern to the kiln, but more especially to

to preserve every part of the same floor in an equal warmth. A departure from this produces an unequal vegetation. In the Hertfordshire method of working, as there never is any increase of moisture after the corn leaves the cistern, an equable and steady temperature in both of the preceding cases can be preserved with much certainty; but under the practice of watering the floors it is not practicable to maintain the same equal degree of temperature either in the progress of the floors to the kiln, or in the different parts of the same floor; and the consequence is that a forced, a fluctuating, and an unequal vegetation is induced in the same steeping, and the Malt thereby becomes greatly injured. It is heat in the first instance that dissipates the water which the grain had imbibed in the cistern, and renders subsequent watering necessary. The floors cannot be heated without an expenditure of moisture, for the warmth sweats the water out of the corn, and when the floor is turned, the moisture on the husk flies off by evaporation; hence, though the water is at first the cause of the heat, the heat again renders more water indispensable. The floors in Hertfordshire are never watered, simply because they are never heated; and it is the cool state in which they are kept in the early stage of malting that preserves the original moisture, and induces that slow and natural vegetation so necessary to prevent the substance of the grain from being run out.

Mr. Reynoldson, in his evidence, states that the water imbibed in the cistern is employed in forming the root, and that the root afterwards is employed in supplying the grain; and hence he infers that fresh water is necessary on the floors. This description is tolerably just when applied to the watering practice, but by no means so in that of the Hertfordshire. In the former the cistern water,

water, as I have already stated, is nearly all expended in the first five or six days by the employment of heat to drive out a rapid vegetation of the root, but in the latter, seven or eight days are employed to vegetate a less root. It is in this that the two practices differ most from each other.

Mr. Reynoldson also states that the water received into the grain becomes decomposed, and after such decomposition exudes from the grain in a state unfit for vegetation; and hence he again infers the necessity of fresh water by sprinkling. This is another of that gentleman's unphilosophical assertions which is without foundation; in the chemical analysis of water only two products are obtained, *viz.* hydrogen and oxygen; and these, when separated, have never yet appeared in any other form than that of gases. The decomposed water of Mr. Reynoldson is nothing more than the pure water imbibed in the cistern, and injudiciously sweated out on the surface of the grain.

Flinty Malt.

Much is said in the evidence about flinty Malt, and the agents of the watering party insinuate that watering the corn on the floors will best prevent it; I have however much reason for believing the contrary. Flint is allowed to differ essentially from the original substance of the barley, and its formation in the Malt is therefore unquestionable. It consists of little hard knobs or ends in the grain, which are insoluble, and so far impoverish the Malt. Its natural cause, I am well convinced, resides in the heat improperly given to young floors, more especially of watered Malt. This heat occasions the glutinous mucilage of the barley to run into a clammy substance, somewhat like bird-lime, enveloping part of the farina, and inspissating first on the working floors and afterward

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on the kiln, hardening into that substance called in the trade flint; and as beating the young floors is a common practice with the watering party, and can only happen in Hertfordshire from the neglect of the workmen, it is surely reasonable to conclude that the watering system, amongst its other evils, will be the principal source of flinty Malt.

Flavour of Malt.

A great deal is said by the agents for watering on the subject of their being enabled to make their Malt of a superior flavour by Sprinkling; but the question of flavour, when applied to pale or common Malt, resolves itself into this simple fact, that that Malt which is worked in the most pure, clean, and natural manner, will be the most free from all adventitious and improper flavour.

While pale Malt is working on the floors, all that can be done is not to give, but to guard it from any peculiar flavour. On the kiln the case is widely different, there, just in proportion as the fire is urged, slowly or rapidly, less or more of flavour and colour will be given to the Malt: it is in this way only that all Malt, expressly intended for the brewing of porter, has its peculiar flavour and colour given to it; but the flavour of ale, generally speaking, is derived from a different source: this latter arises from the union of a peculiar oil of a greenish colour, naturally abounding in hops, with a portion of the unfermented wort, and the mucilage and alcohol of the fermented part; these judiciously blended together in a due proportion, give to ale all its agreeable taste; but the palate being an arbitrary organ, and differing widely in different places, no established rule can be laid down for adjusting the flavouring of ale: in some places the sweet taste of the Malt is required to be pretty full in the mouth,

mouth, by leaving a larger proportion of the unfermented wort; while in others it is required to be almost entirely dissipated by a more complete fermentation; and between these a variety of flavour may easily be imagined.

What has been said will be sufficient to explain the case as far as regards that flavour which it is desirable to obtain; but there is another point of view in which it is to be considered, and that is, those bad flavours which Malt acquires in its progress through a manufacturing state, and which greatly depreciate its value. The principal of these, and indeed the only one with which the present enquiry is immediately connected, is that of mouldy Malt, arising from the vegetation ceasing after having made some progress; most of the grains which are bruised by being trodden under the feet of workmen or others while in a state of malting, pass into a mouldy or putrid state; but the principal source of mouldy Malt is in wet grain being buried under other corn, and too long excluded from the influence of the atmosphere: a simple experiment will sufficiently illustrate this; if a sample of half-malted barley be placed under a bell-glass, air tight at the bottom, the corn will vegetate freely until the enclosed oxygen is all consumed, when the vegetation will cease, and the grain will pass into a state of decay similar to mouldy Malt, and the more moist the grain was when enclosed under the glass, the sooner it will become mouldy.

In watering on the floors it is invariably the practice to turn over the grain immediately after it has been sprinkled, hence the wet corn is placed at the bottom; and it will necessarily happen that some of this will again be thrown undermost in the subsequent turnings, and this cannot fail to destroy the vegetation and render such grain mouldy; and not only the grains individually dead, but

all others with which they happen to come in contact will acquire a disgusting taint, which will afterwards materially affect the flavour of the liquor drawn from the Malt.

Weight of Malt.

Several erroneous opinions are delivered in the evidence given before the Committee respecting the goodness of Malt being determined by its weight; abstractedly considered, weight indeed does not afford any certain data for estimating the worth of Malt, because bad Malt may be either heavier or lighter than that which is good. If the vegetation of the grain has been imperfect, or not carried sufficiently far, the product will be part Malt and part barley, and of course heavier than good Malt: but if on the other hand the vegetation has been carried too far, too much of the substance, and of course weight, of the grain will have been driven out, and the Malt will be light in proportion as the injuring cause has been allowed to operate: in this way Malt may be rendered light and unproductive to any extent at the discretion of the maltster.

But notwithstanding all this, in every instance where the grain has been perfectly malted, weight is the only certain standard now known for determining the value of Malt; and this is now so well understood in the markets, that it is not unusual for the buyer of Malt to be provided with a pair of scales and a small measure, and to govern his opinion of the price by the weight which his measure of the sample yields. In all Malt, therefore, which has been perfectly malted, there can be no question of the heaviest being the best; and in this respect the Hertfordshire Malt preserves a distinguished superiority over all watered Malt.

Varieties

Varieties of Malt.

Strictly speaking, there are only three varieties of Malt, *viz.* brown, amber, and pale Malt: the first two are peculiar to porter, and have special reference to its flavour and colour; the third is the general basis as well of all porter as of every other species of malt liquor; and it is the only one which merits any consideration in the general question of malting. Brown Malt receives all its peculiar qualities in the kiln, by an operation called blowing; it is spread there very thin, and a very quick and active heat is passed through it from flaming faggots: the sudden application of the heat converts the moisture in the grain into vapour, which blows up the husk, and the heat catching it in its distended state hardens and prevents it from collapsing; hence the grains of such Malt are large and hollow, and increase the measure from one to two bushels in a quarter. The saccharine of this Malt is nearly all destroyed by the operation of the fire, and its sole object in porter is to communicate flavour and colour; but as these qualities are probably to be obtained from other materials than Malt, some porter brewers are not using it all, and the making of it is very rapidly declining. Amber Malt is a species between brown and pale, and is also made on the kiln by giving it less fire than the former, and more than the latter; it is still generally used in porter along with pale Malt, but the quantity made is inconsiderable.

As bad flavour in Malt subtracts from its value, and the charge of producing was strongly shifted by the watering party from themselves to the Hertfordshire Maltsters, the present portion of the subject is material in the enquiry; and from what has been said it may be readily understood that flavouring, when applied to the working

floors, can only mean manufacturing the different steepings there as sweet and clean as possible, and thereby not giving but guarding against any peculiar flavour.

Varieties of Barley.

In the evidence given before the Committee, the agents of the watering party have set up a very material distinction between what they call heavy and light land barleys, and they appear to have laid much stress on this distinction, and to have considered it as one of the chief supports of their case; to me, however, it seems no other than one of those artful subterfuges so commonly resorted to by artful and interested traders in revenue questions, merely to obscure and disguise the true state of the matter at issue.

On all the numerous gradations of soil, from the lightest down to clay itself, barleys are produced, varying in every degree, chiefly as to colour and thickness of skin; but this variety is not, as is attempted to be set up, a local circumstance. It abounds every where, because light and heavy soils do every where abound, and it is only to the extremes, and not to the multitude of intermediate gradations, that any thing advanced before the Committee can fairly be referred. Certainly to mix the very coarsest with the very finest barleys in the same cistern would be improper, but each sort can be well malted separately without any aid from watering on the floors, which is in no respect more necessary for what is called the heavy than it is for the light land corn.

The several witnesses who have spoken to the case have advanced that more water is required for the coarse than the fine skinned grain, but the fact is probably the contrary. The thin skinned barley, being the largest and plumpest corn, will certainly require the most water for its

its vegetation, but on account of its more pervious husk, it will sooner imbibe its proportion of the fluid. Hence it is that thick skinned grain does not actually require a larger proportion of water but only of time in the cistern to absorb its proportion; and having accomplished that, it is equally, and perhaps better, fitted for going through the subsequent process of malting without a further supply, as its thick husk is more likely to retain the moisture which it has got.

If, however, the reason of the thing did not sufficiently prove it, the testimony of Messrs. Clough and King fully establishes that better Malt can be made from coarse barleys without than with watering upon the floors; and in every place where I have been, except giving the thick skinned corn a few hours more of time in the cistern, no further attention is paid as to treating them differently from others.

It has long been a pretty generally received opinion amongst farmers and others, that barleys grown on heavy lands contain a larger proportion of earthy matter than those produced from light lands; but from the chemical analysis of both kinds it has been found that there is no truth in this opinion, and that the proportion of calcareous and other earths is the same in light as in heavy land barley, and that the real difference between the two lies merely in the husk; all therefore that we are authorised to conclude on the subject is, that in equal weights or measures, the coarser-skinned grain contains a large proportion of waste, and on that account only less proper for the purpose of malting.

There is another distinction of barleys which the agents of the watering party have advanced in support of their case; and that is, that though the large fine barleys of Hertfordshire and in the Southern parts of the kingdom are

are malted without watering upon the floors, yet that the inferior corn more Northwards does require and cannot be malted without Sprinkling: now I am well convinced the case is directly contrary to their statement. It is a well known fact that the thinner, lighter, and more inferior the barleys are, the more apt are they to run themselves out in a too quick vegetation, and having of themselves but little substance, the less of it can be parted with in the process of malting; whereas the large fine plump barleys of Hertfordshire both require more water to malt them, and could much better admit a portion of their substance to be wasted in the process; and such barleys actually having a less aptitude to run out in vegetating, they would require and would stand watering much better than the others; the conclusion therefore is just, and the fact really is, that as the finest barleys in the kingdom are actually best malted by not being watered on the floors, so the inferior kinds would be benefited in a higher proportion by being restricted to the same process for which they are naturally better adapted.

Frauds of Watering on the Floors.

There are no frauds of any extent practicable at a malt-house except those which are immediately connected with and entirely depend on the practice of watering on the floors. These last are three in number, *viz.* draining the cistern before the time prescribed by law, in order to keep down the gauges in the couch; wholly emptying the cistern to be fraudulently worked as a distinct floor; and privately plundering the cistern of parts of the corn, in order to be mixed with the youngest floor. As the grain in each of these frauds is short-wet in the cistern, it would be impracticable to carry it forward in a sufficiently malted state to the kiln without watering it upon the

the floors. Of the first I shall say nothing as it explains itself. Instances of both the others I have myself detected; and what is more, an instance of the second was in a foot walk, and had been practised to a great extent. But it is in rides where it can be pursued almost with impunity, from the officer's visits at the malt-house being only two or three times a-week; and I am inclined to believe that it is followed in such situations to a degree much beyond what has yet been discovered or even disputed. It requires indeed the use of a large kiln, and where that has been provided, it is only necessary to get the oldest floor there immediately before the cistern is fraudulently emptied; and though it must, like every other fraud, at particular stages of its practice, afford indication of what is doing to a vigilant and intelligent officer; yet, for the most part, an officer may survey in the usual manner for a length of time without observing any thing to call forth his suspicions. I can even readily believe that a cautious and artful Maltster may defraud the revenue of half the duty which he ought to pay by means of this fraud, and yet incur in the practice of it but very little risk, provided he is indulged with watering the short wet corn on the floors.

The third fraud of robbing (or as it is called in trade gelding) the cistern, and mixing the plundered corn with the youngest floor, certainly has been, and there is reason to fear it is yet, practised to a most injurious degree, as the present restriction against watering on the floors does not extend to a period sufficiently late to exclude its practicability, and which indeed may be equally said of the preceding fraud. The one, however, of which I am now speaking is too well known at the Board from the numerous detections which have been made of it, to require any particular description or comment from me.

Present

Present Restriction against Sprinkling.

When the present restriction against watering on the floors was established, a very material circumstance, intimately connected with it, was probably in some degree overlooked, or at least not sufficiently adverted to. This circumstance is, that in every instance where short wet corn is fraudulently laid upon the floors, it does not take the true age when it was actually removed out of the cistern, but a false age of the same date of the preceding steeping. This arises from its being either mixed with and of course becoming part of the youngest floor, or taking its place in the officer's account, and passing for it through all the subsequent stages of malting. The regulation of this false age is very much within the power of the fraudulent Maltster; for as he steeps when he pleases, he can determine the day and hour when he will empty privately the cistern, and he can keep back the youngest floor from growing by spreading it very thin. In this way three days of false age can be readily gained, and such corn will come in course to be watered on the seventh, instead of the tenth day, as intended by the restriction; but had the Maltster a discretional power of watering, he would not do it sooner than about the sixth day; hence the present restriction against watering, as far regards fraud, cannot be considered as operating to any very useful purpose; and even in cases where no fraud is practised its operation is very feeble indeed, and the great extent to which watering upon the floors is still followed, sufficiently proves the inutility of the present restricted period.

The former restriction of twelve days was much more effectual, as short wet corn could not be worked up to that period, even with the false age already spoken of, without

without watering it, and by watering it illegally, the penalty for doing so was not only risked, but what is much more, great hazard was incurred of disclosing the fraud itself, the very circumstance of watering being matter of suspicion sufficient to direct specially the officer's attention to the state and condition of the particular steeping which he found illegally watered.

The restriction of twelve days also took away from the interested Maltster the mischievous means of wasting the substance of the corn, by throwing out too much vegetation, and making that light unproductive Malt which actually is at this time so abundant in the market. I would therefore humbly submit it as a matter of much importance, and as a case resting upon grounds which cannot fairly be controverted, that the revenue on Malt can only be protected from very extensive depredation, and the quality of the commodity manufactured in the greater part of the kingdom preserved from a most improvident waste, by the restriction against watering the grain upon the floors being extended from its present period of nine to its former of twelve days.

What has hitherto been stated in this Report is the result of my own previous experience and knowledge in the survey and manufacture of Malt; but I have now to detail the various practical facts and circumstances collected on my journey through many of the most considerable malting places, and from which I am but just returned.

My first progress was into Hertfordshire, and into the north-eastern and western directions from London, where the practice of malting prevails without watering upon the floors. I visited 115 different malt-houses of this description, all in full work. The periods of steeping were generally twice a week, and the time of keeping the corn under water varied from 48 to 56 hours. This period was

shorter than had usually been employed, owing to the barleys of the last year being lighter and thinner than in former years, from a want of rain at a particular period of the crop. As the barleys, however, were hardening by longer keeping, they would take more water in the cistern.

In my inspection of the numerous maltings, I paid every attention to the state of the corn in its progress through every stage. The same process uniformly prevailed at all, and the only discoverable difference was readily to be traced in the conduct of the workmen; for where the most industrious and steady men were employed, the corn was in the best condition; but the management and object of the process were at every individual house the same.

The system of malting pursued through this part of the country is simple and obvious, and contains nothing of secrecy or difficulty that can form an obstacle to its adoption in any other part of the kingdom. It consists, in the first instance, in giving the corn a due proportion of water in the cistern, according to its condition. The thinner and lighter the grain is, the shorter is its period of steeping; and the larger, drier, and bolder the barley is, the longer it is continued under water. When thrown out of the cistern it remains in the couch from 26 to 30 hours, and it is kept a day longer at a depth of from 10 to 16 inches, varying with the state of the weather. In this situation a very moderate rise of temperature comes on, which is carefully watched, and checked by turning the grain. By the fourth day the root has come freely out, and the corn is spread abroad in the floor very thin. At this time its temperature is very little above that of the air in the malt-house, and the steeping is continued to be worked in this cool state up to the eighth or ninth day,

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and during this cool part of the process, the root, which at first shot out strait from the corn, curls back upon it, formed a little bushy knot of curled fibres, which does not afterwards grow any longer, and rarely exceeds half an inch in length. By the eighth day the acrospire has advanced about one-third up the grain, and to promote its further progress, the grain after this period is laid a little deeper, and so gradually increased up to the kiln. The completion of the process is judged of by the acrospire having reached two-thirds, or at most three-fourths up the grain. The circumstance therefore which chiefly distinguishes this process of malting, is that of working the steepings as cool as possible during the first half of the period of operation, and gradually increasing the heat during the other half up to the kiln.

The numerous floors which I examined in every stage of operation, bore the most unequivocal appearance of no water having been employed in working them, and yet the vegetation was regularly and steadily kept up to the kiln. I examined specially all the old floors in the last stages of the process, and even on the kiln, and found them fresh, sweet, and in an evident state of healthy vegetation, and in some instances where the grain had been some time on the kiln, the quantity of moisture, which was flying off in a thick dense vapour, afforded satisfactory testimony, that barley, when properly treated through the working process, can carry along with it a sufficiency of the cistern water for all the necessary purposes of malting.

So very evident indeed was this, that it would only have been requisite to allow the oldest floors to have lain for a proper time undisturbed, in order to their springing up into a thick green bed of living plants. I was especially attentive to this circumstance, and can now confi-

dently declare, that the statement of Mr. Reynoldson before the Committee, wherein he affirms, in such express terms, that the putrefactive fermentation formed a part of the Ware process of malting, has, in fact, no foundation whatsoever.

I conversed with a gentleman who examined the same three floors on the following day after Mr. Reynoldson's inspection of them, and who declared, that though the corn was not in good condition, owing to the warm state of the weather, and advanced season, (they were the last steepings,) yet that the vegetation was completely alive on all of the floors, and that there did not exist a single fact or circumstance in the case, which could authorise the strange account given of them. All the Maltsters also with whom I conversed on the subject, ridiculed the notion that putrescence could have any share in their process, and expressed their surprise, that so wild an opinion could have been advanced or encouraged by any one.

Most of the malt-houses consist of a range of building three stories in height, of which the two uppermost are commonly boarded, and the lower one plaster. Each steeping is divided into three parts, and worked on a separate floor. The boards are warmer than the plaster, but being higher, the grain is situated cooler on them. This, however, contrary to what is stated against it in the evidence by the watering party, produced no irregularity in the vegetation, for the corn situated the coolest is worked the deepest; and in this way, the workmen, from practice, can keep the pieces very nearly at the same temperature. I paid particular regard to this fact, and being provided with a thermometer, it enabled me to determine it very exactly.

The malting rooms were kept remarkably open and airy, by throwing all the doors and windows open, and allowing

allowing the wind freely to blow over the corn. In several houses even flocks of sparrows were feeding upon the floors, and so tamely as to shew that they were familiar with the place, and visited it without interruption. I was already well aware of the great importance of fresh air in malting, but did not imagine that it could be so freely admitted in the process where watering upon the floors was not practised, without inducing a too great expenditure of the cistern water by evaporation.

At every place, and in most of the houses, I conversed with the common workmen, and endeavoured to collect from them their practice and ideas of malting. Many of them were old and intelligent men, and had worked in malt-houses all their time. They declared, they had never used themselves, or seen others use, any water upon the floors; and they all believed it could not be employed there without injury. When asked, why they worked the young floors so cool? They said, to prevent the corn from sweating out the cistern water, and to keep the floors back (meaning the vegetation). When interrogated why it was necessary to keep back the vegetation at first? they replied, if it was allowed to go on too quick at first, it would both sweat out the moisture, and drive out a long tail (root). And when questioned as to what injury would result from a long root? their reply was, it would run the inside of the corn out, and make light Malt. These were the actual expressions of many, and the ideas of all; their opinions of the acrospire were also very similar. Most of them signified that they wished to get it no farther than over the back of the corn, meaning the thickest part of the barley, and none were desirous of carrying it more than three-fourths up. All of them maintained that the barley might be perfectly malted beyond the acrospire, and that driving it up to or

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beyond the end of the grain would spend the inside, and make the Malt less productive.

My enquiry was not limited to the common workmen, for I endeavoured to select and converse with many of the most intelligent and best informed masters; and I met with several who afforded much useful information. Some of them had worked many years themselves, and their Malt was in the highest repute in the markets; their account of the process of malting was to the following effect: that the cistern water was amply sufficient when the working was properly conducted, for the malting of every variety of barleys. That they had malted barleys from every kind of light and heavy soils, and from almost every country, even as far as Scotland on the one hand, and Devonshire on the other; and they considered it as entirely groundless to imagine that there did any where exist a kind of barley which required watering on the floors more than the Hertfordshire. Their ideas were the contrary; for the more inferior the barley was, the more readily it would spend itself by running out in a quick vegetation; and the less there was of the original substance, the less of it could be spared in the process of malting it; whereas their own large plump corn would, if the thing were necessary, stand watering on the floors beyond any other kind, less bold and abundant in body. Nevertheless, though the fact really was that their own large grain would stand watering better than any other of an inferior quality, they were well convinced, that were they to practise watering, their Malts would be light, and much inferior to those which they now make without watering; and they considered it as a case almost self-evident, that if their own full-sized barleys could be well and even best malted without watering, the malting of all other inferior kinds might be still easier accomplished in the same way.

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They were all of opinion, that weight is the best criterion of good Malt, when the grain is perfectly malted, and this was now so well known in the market, that weight and tenderness were the only qualities in estimation there, and their own Malts preserved their superior prices entirely from these characters. In the working process they knew that both the root and acrospire consumed the substance of the barley, and that the only mode of preserving weight in Malt, was by preventing these from proceeding any farther than was consistent with the malting of the barley; and that this could not be accomplished if the floors were watered, from the too powerful vegetation which it promotes. Some of them had been down in the lower parts of Suffolk, and in other places were watering is practised, and had observed there, that the custom of watering resulted from improperly allowing the young floors to heat, in order to forward the private views of the Maltsters; and the consequence was, that much more root and a longer acrospire were driven out in these than in the Hertfordshire Malts, and the former were, on that account, for the most part lighter than the latter, by twenty pounds in four bushels.

I also met with several intelligent common brewers, who were likewise considerable Maltsters, and who declared, that their experience in brewing had confirmed to them that upwards of half a barrel of wort of equal quality could be drawn from a quarter of unwatered Malt more than from Malt which had been watered on the floors. They related many other interesting particulars, all directly in favour of Malt made without watering; and they declared their opinions, both as brewers and Maltsters; not only to be decidedly in preference of such Malts, but also that every variety of barleys might be readily

readily and best malted without any sprinkling upon the floor.

In my progress through the country I visited the breweries, and examined the ales and goods in the mash tubs, and more especially the grains, which were thin transparent husks, and more perfectly spent than I ever recollect seeing before. The usual lengths were three barrels and a half to a quarter of Malt, and this I know to be upwards of half a barrel more than the brewers in Manchester draw from their Malts; and the ales of the latter I also think inferior.

In the course of my journey I met with only two houses where any brown Malt was making, and at one of these only two steepings were in operation. At another place a little amber Malt was in process, and these were the only porter Malts (except the pale) which occurred to notice in the whole enquiry. In truth, there cannot prevail a more erroneous opinion than that which the agents of the watering party endeavoured to inculcate, and apparently with much success, in the Committee of Enquiry into Malting, that the Hertfordshire Malts are manufactured with an exclusive view to the brewing of porter, and are, on that account, unfit for the brewing of country ales. Very little porter indeed (I found it only at one house) is drank in any of the places which I visited; and the ales are all brewed from the same pale Malts which are sent in such abundance to the London market.

The vast mass of pale Malt which I saw in operation is perfectly well adapted for the brewing of every species of the best ales that are or can be made in any part of the kingdom; and I humbly think that its superior weight, price, and quantity of wort drawn from it, all demonstrate that it really is the best and most productive Malt made

made in the kingdom; and sure I am that all its superiority results from the mode of its manufacture.

Much the greater part of this Malt is made from barleys purchased in London, and brought thither from various and distant parts of the country. I specially examined the barleys at most of the houses, and found them of all varieties and qualities. Very little regard was paid as to keeping the light and heavy land barleys apart, provided they were nearly of the same size, but small and light corn was separated from the large and stronger grain.

After returning to London from the north, I again set out into Surrey and the country west of London, where I found the practice of watering the corn upon the floors very general. I visited in all about 60 malt-houses of this description. At some the steepings were made at every third, and at others every fourth day. From four to six floors were depending at each house, and the steepings were dried off a third part at a time. For the first three days after the barley is thrown out of the cistern it is kept sixteen or eighteen inches deep, and in that time sweats very much from the heat which is allowed to accumulate in it; and when the root is quite out, it is thrown abroad as a floor. The root runs out strait, and I generally found it on the fourth day as long, and in many instances longer, than it was in Hertfordshire on the eighth day. After much of the cistern water had been thus sweated to the outside of the corn, and the latter had been spread out very thin, a great part of it was carried off by evaporation, insomuch that, on the ninth day, the root which was so forward on the fourth, was gone back in its vegetation, and in many instances become flaccid and brown; and it would certainly have been impracticable to carry such grain forwards to the kiln in a proper state of malting without watering it; and this accordingly was done as soon as the legal period of restriction was ex-

pired. The operation as I saw it performed was done at three separate Sprinklings, turning over the corn each time, and then leaving it undisturbed from twelve to eighteen hours, according to the weather; in some cases the operation is repeated, and in others not. The water thus thrown upon the grain generally drives out a second root, not from the same aperture as the old one, but by the side of it, and this blows out the end of the corn, and makes an increase in the measure of the Malt; and so very material is this considered, that the workmen, in turning the floors, tumble about the wet corn in a way purposely to beat off the old root, and in many cases I was assured they employ a besom to sweep it off.

To obtain this increase of measure is, most certainly, one of the objects of watering the floors. Before the wet corn can be brought forward to the kiln, most of the water given it on the floor must again be worked out of it, because if it is laid upon the kiln too moist, it will shrink in too much, and thereby disappoint the Maltster of one of the objects which he had in view, the increase of measure in the bushel; and the circumstance of being obliged again to work the water out of the grain, keeps it several days longer from the kiln than would otherwise happen, but yet it is very far from being so dry and floury when brought to the kiln as the Hertfordshire Malt.

The same object, that of an increase of measure, also occasions the acrospire being driven quite up to the end of the grain, and very frequently much beyond it. The longer it is suffered to grow the more it distends the body of the corn, and of course increases the bulk of the Malt. In several of the old floors which I examined, I found the acrospire driven an inch out of the grain, and so unequal was the vegetation in many of the same steepings, that the acrospire was of all lengths, from upwards of an inch out down into the body of the grain. In many floors too

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the corn was run together in hard bunchy knots, by the fibres of the root growing and strongly matting together. This originated on the water given on the floors puddling in holes, and the corn there getting a larger proportion. All this mischievous inequality of vegetation arose entirely from the water given on the floors, and it is more or less inseparable from the practice. Nothing similar appeared on any of the Hertfordshire floors; and I also observed that many of the old watered floors were mouldy, much beyond any which I saw in Hertfordshire. It is called in the west finnery, appearing to be very common in those maltings, and it was said, by some, to be occasioned by the floors not being watered more early. But this was rather an excuse than an explanation, for it very evidently results from the wet corn heating, and being afterwards excluded too long from the influence of the atmosphere.

Exclusive of the double root which I have mentioned, and which cannot fail greatly to exhaust the corn, I paid particular attention to the quantity of root which appeared on the grain in most of the floors, and it certainly was not less than double the quantity which I had observed in the Hertfordshire floors; and this I consider as one of the chief causes of the lightness and inferiority of the Malt.

In the west, as in Hertfordshire, I entered into conversation with the common workmen, and endeavoured to draw from them information on the subject of their employment. Most of them maintained that watering on the floors was beneficial, but when interrogated as to wherein the benefit consisted, the conclusion almost invariably was, that it was better for their masters, meaning that it produced an increase of measure. Some of them even admitted that they knew of no other purpose it answered, and others could only say that along with an increase it also improved the husk of the Malt, by

making it brighter. There was not one, however, who contended that watering made better Malt for a brewer, and almost every individual of them allowed that it threw out more root, and on that account made light Malt.

I also enquired of and waited upon several of the most intelligent Maltsters, to learn what they had to say upon the subject of watering. Some of them said they had made Malt without watering, but that when so made, it measured less than the original barley, and the trade was this season so bad, that without an increase of measure there would be no profit; they all contended for this increase of measure, and one of the principal Maltsters declared he had made good Malt with an increase of two bushels in twenty, but certainly the epithet can apply to such Malt in no other way than good for sale. The same gentleman declared he was making his Malt this season without watering, but the condition in which I found his corn on the floor evidently disproved this assertion. The reason he gave for not now watering was, that he made chiefly for a considerable brewer, who insisted on the grain not being watered; and the brewer's reason for this was said to be, that watering so late as the tenth day made the Malt finnery (mouldy), and injured the flavour of his ale. It is, however, easy to imagine that the true reason of the brewer was, that watering impoverished the Malt.

The Maltsters all complained of being greatly undersold by what is called ship Malt upon the coast, and said they had heard of many sales below the value of the barley and duty, and they acknowledged that such Malt was of a wretched quality (the expression was "as light as straw"); and that the injury it received in malting, and the frauds which occasioned its being sold so low, could only originate in the abuse of watering profusely on the floors. I met with no Maltsters who ventured to main-

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tain that watering on the floors made Malt better for the brewers; but on the contrary I found brewers who were making their own Malt without watering it, and precisely similar to the Hertfordshire Malt. There were also a few other houses working in the Hertfordshire way without watering, though the Maltsters contended for the practice, but alledged, that as they could not water so early as they wished, and watering so late as the tenth day injured the Malt, they had left it off altogether.

I found the malt-houses very large, roomy, and spacious, beyond any I had seen before, and incomparably more so than the houses in Hertfordshire; but notwithstanding their superior size, they were kept much darker and closer from the external air than the latter, and this circumstance I consider as very injudicious, and as one of the causes operating to produce their finnery or mouldy Malt. Several of the old floors were far more decayed than any I met with in Hertfordshire.

In the latter place the chief object in the manufacture of Malt is weight; in the west it is an increase of measure, and this was said to be from one or two bushels in twenty.

The prices of Malt in Hertfordshire were from four pounds to guineas per quarter, in the west they were said to be from seventy-four to seventy-eight shillings; it is, therefore, evident that the profits on their light inferior Malts are at least equal to those on the best made Hertfordshire Malt, notwithstanding the apparent difference in the respective prices, and this without considering any advantage from fraud, or otherwise. It is admitted on all hands that in unwatered Malt there is a loss of measure, the Malt not yielding the same quantity as the barley. I also understood that at many of the houses which I visited the frauds of short wetting had been very extensively practised, and numerous detections and prosecutions

sections had been had thereon, and it is impossible to doubt that these frauds have been and still are looked up to as a source of very productive emolument, exclusively annexed to the watering system. In fact, notwithstanding the preference given in the market to the Hertfordshire Malts, they urge no complaint against that quarter, or appear to consider the Maltsters there as at all their rivals; but they speak of being greatly injured by what they call the low country and coast Maltsters; and they all admit that the inferior priced Malts made there can only arise from fraud and watering, admitting, certainly, that their own frauds have been suppressed while the others are still going on.

Having thus had opportunities of personally examining the two different modes of manufacturing Malt, I can now speak more confidently on the practical merits of each. In Hertfordshire they are endeavouring to preserve all the substance they possibly can in the Malt for the purpose of obtaining weight, whereas in the West they are purposely driving the substance out of the grain, in order to blow up the bulk of the Malt. Both objects admit of different degrees of abuse. In Hertfordshire I could observe that some of the Maltsters were taking their Malt too early to the kiln, and were drying it there less perfectly than it ought, in both cases to promote its weight. In the west, besides wasting the corn by running out a second root, the acrospire was allowed to shoot up out of the grain, in order that it might spread over the back, and increase the measure. It is also material to remark, that the lighter the Malt is, the less it will press down in the bushel, and thereby measure the more. The Hertfordshire abuse has its limits, and can never extend to any mischievous length without defeating itself; but the watering abuse supports itself by the emolument rising in a nearly proportionate ratio.

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Of the relative values of the respective Malts it would be simple to make a question; it is even decided by the very principles upon which the two parties proceed: the one labours to preserve the substance of the Malt, the other purposely to dissipate it. The emolument of the former hangs on the specific gravity of the commodity, and that of the latter on its levity.

The practice of watering upon the floors, I humbly presume, has never had or can have any other object in view than that of the individual interest of the Maltster; and as the sacrifice which he makes in the light and impoverished article which he manufactures, is a loss that falls wholly on the consumer, and he, very generally in the country, knows but little of the injury which has been done; all the advantage, without any share in the loss, rests with the manufacturer.

The numerous detections of the frauds of short wetting sufficiently establish their extent; and the great quantities of low priced Malts that are still brought to market, prove that these frauds are yet in operation; and indeed, to any one conversant with the revenue, it is easy to imagine that this must be the case, for it is well known that excise traders, who have once shared in the large emoluments of a considerable fraud, will not, even by numerous prosecutions, be driven from the practice while they are left in possession of the same means. It is on this account that so many successive improvements are necessary in the revenue laws; as new frauds are developed, new legal regulations are become expedient, to deprive the unfair trader of his nefarious means; and this I humbly think is the only effectual mode of suppressing the gigantic frauds of short wetting at malt-houses.

That the present legal restriction against watering scarcely operates at all in protection of the revenue, and but very feebly in aid of the commodity, cannot, I humbly

bly conceive, be doubted. That material fact, that all fraudulently short-wet corn assumes a false age, *viz.* that of the preceding steeping, as soon as it is laid upon the floor, and that the regulation of such false age is very much within the power of the Maltster, fully proves that such fraudulent corn can be timely watered, under the present restriction, almost with impunity; and the general practice of watering, which is still so much pursued, also shews that the quality of the Malt is not at present within the limits of legal protection.

The former restriction of twelve days was much more effectual for both purposes, and certainly afforded all the accommodation that a fair and honourable investigation of the case can discover to be necessary; and to sum up the whole: although that branch of the subject which includes fraud on the revenue be of itself of sufficient magnitude to demand strong legal interference in the process of malting, yet in my humble judgment, that most improvident waste of the commodity and mischievous injury to the community, which certainly do result from the practice of watering Malt upon the floors, furnish out a case of national grievance equally deserving the consideration of the legislature.

Account of the Methods of making Bricks.

By Mr. JAMES MALCOLM.

From his COMPENDIUM of MODERN HUSBANDRY.

LARGE quantities of bricks are annually made in different parts of the county of Surrey, and particularly near the metropolis. The manufacture has of late years become an object of revenue, and as such entitled to some consideration; the manufacture is besides of the utmost importance to the community, inasmuch as the value and comfort

fort of our dwellings must depend in a great measure on the quality of the materials with which they are constructed; and bricks form no inconsiderable part of them. I say it is material to us, because if the bricks with which our houses are now almost uniformly built are in quality defective, and if the timber be of a similar description, we ought not to place much dependance on the solidity of the edifice.

The soil on the Surrey side of London is only calculated for certain sorts of bricks, and these, it must be confessed, are inferior to those made in Middlesex. We have neither depth, nor that pure medium argillaceous substance, which is so essential to form the perfect brick; we have either too much silex, or, to speak the common language, too much flinty sand; and the stones are too abundant, large, and too near the surface, which cause the bricks to vitrify, and thereby their colour and quality is injured; or we have a portion of calcareous matter, which causes the bricks, after being taken from the clamps, insensibly to moulder away by exposure to the air or to moisture; and where it is argillaceous, as in Camberwell and Dulwich parishes, it is to that extreme, as to be impossible to be moulded without the assistance of some adventitious combinations. What those combinations are, which form the several varieties of bricks manufactured in the county, together with some cursory remarks, will form the subject of this essay.

Synopsis—At Kennington, at Walworth, at Camberwell, and in Battersea parishes, we have manufactories of bricks, to a much greater extent probably than all the rest of the county united. In analyzing the earth which has been generally used, I followed the plan of the learned Bishop of Llandaff. Eight ounces of earth taken out of the pit as they were digging it (Mr. Fentiman's), and moulding it into an oblong square, I placed on the hob

of a Bath stove in my study, where a constant fire was kept for seven days. I then weighed it, and found it had lost 1 *oz.* and ½. I did the same by that at Walworth, and during the same time it lost nearly 2 *ozs.*; that at Camberwell lost in the same time 3 *ozs.* 4 *dwts.*; that at Battersea, 2 *ozs.* 6 *dwts.* In the solution of these earths, after having exposed them to the muriatic and the acetous acid, it was evident that, besides a large portion of pure argil which the earth at Camberwell contained, there were not less than 18 parts in 100 of iron, a small portion of silex, and about six parts in 100 of calcareous earth: and it will be seen, that the quantity of water which the clay and the calcareous earth held was considerable; from this I infer, that although the colour of the bricks, and the difficulty and consequent expense in moulding the latter was greatly against the manufacturer, yet, as to the materials, they were far superior to the others in an essential property, I mean durability. Those at Kennington and Walworth were nearly similar in their products, the latter possessing the most argil; and those at Battersea still more; the earth therefore imbibing more moisture, consequently loses more in burning.

The moulds used in making every sort of brick for building purposes, are ten inches in length, and five in breadth; and the bricks when burned usually measure nine inches in length, and four and one-half in breadth, so that the clamp shrinks about one inch in ten. But the degree of contraction (as we have before seen) which clay undergoes in being burned, does not absolutely depend upon the purity of the clay; for as some clay imbibes more moisture than others, if that which imbibes the most is not exposed a much longer time to the frost to divide and separate its particles, and to the heat of the sun to exhale its moisture, than that which imbibes less and is a shorter time exposed, it follows, that while the one will

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be reduced one inch, the other may lose two or more. Again, the heat of the kiln or clamp, and the situation of the bricks as to heat, will vary the diminution of the subject to be burnt. It is of consequence therefore, in the making of sound hard bricks, that the clay should be dug two or three years before it is used, in order that it may be pulverised; and the oftener it is turned and incorporated, the better will be the bricks. The earth should have sufficient time to mellow, ferment, or digest, which will render it more apt and fit to temper; and this operation of treading and tempering ought to be performed more than doubly what is usual, because the goodness of the bricks wholly depend upon the well performance of its first preparation, since the earth in itself, before it is wrought, is generally brittle, full of extraneous matter, which requires to be removed, and as it were without unity and stability; but by adding small quantities of water by degrees to it, and working and incorporating it together, the several parts of it are opened, and by being thus exposed to the atmosphere a tough gluey substance is formed, which, without such tempering, treading and beating, could not have been produced. I can only compare this preparation of the soil to that of making bread. When there is a due quantity of water put to the flour, and well wrought up together, such bread becomes not only smooth and firm, without having eyes or being subject to crumbling, but it eats sweeter and mellower, and becomes easier of digestion, affording far better nourishment than such as is over-watered, heavy, and not sufficiently tempered; provided the other operations, which belong to the making of good bread, such as baking, &c. be properly performed.

Bricks thus tempered become solid, smooth, hard and durable; and one brick thus made takes up nearly as much earth as a brick and a half made in the common

way; but these are light, full of cracks, and spongy, owing to the want of due working and management; and the mixing of ashes which is now the uniform practice about London, and light sandy earth which is usually practised in the country, to make them work easy, and with greater dispatch, serves also to save coals or wood in the burning them.

TO BE CONCLUDED IN OUR NEXT.

Intelligence relating to Arts, Manufactures, &c.

(Authentic Communications for this Department of our Work will be thankfully received.)

On the Cultivation of Flax and Hemp.

As the interruption of all commercial intercourse for the present between Great Britain and the Northern Countries of Europe, will not only prevent a continuance of the importation of flax and hemp for the navy, but probably render necessary the cultivation of that vegetable on an extensive scale in our own country, the following information on the subject has been collected from the Report of a Committee of the House of Commons in 1802, on Acts relative to the linen manufacture in Ireland, and from the evidence laid before them.

The Committee report, that by an Act passed in the Parliament of Ireland in 1778, it was enacted that, after the first of August in that year, the collector or chief officer of any port, into which any importation of flax-seed or hemp-seed should be made, should immediately after the landing of the same, and before payment of the bounty, summon and convene three persons not importers of flax seed, such as he should judge best skilled in flax-seed; to whom he was thereby required and empowered

powered to administer an oath that they would to the best of their capacity, give full and true judgment in respect to the soundness and quality of such flax-seed and hemp-seed as shall be produced to them, and declare in like manner whether the same was or was not fit for the purpose of sowing; and that the said collector or chief officer should produce to the said several persons such cask or casks of flax-seed or hemp-seed as should be imported, and that the said persons should report their judgment thereof to the said collector or chief officer, in writing, with their names subscribed thereto; and if in the said report two or more of them should declare that they had viewed all and every cask of such flax-seed or hemp-seed, expressing the number exhibited to them, and that they were of opinion the same was clean, and of sound and good quality and fit for sowing, the collector was required and directed to brand or otherwise mark, at or near the bung-hole, each and every of the said casks, with a mark expressing the year and month the same should have been so inspected and approved of by the said persons so summoned and convened as aforesaid; for every which brand or mark, the sum of sixpence *per* cask and no more was to be paid by the importer to the said collector or chief officer so marking or branding the same; and that no bounty granted by any laws then in being should be paid to the importer of any flax-seed or hemp-seed, which had not been first inspected, reported, branded, or marked, as aforesaid.

They also report that by an Act of the same Parliament, passed in the year 1780, all bounties and premiums were revoked for any flax-seed imported into Ireland; but that by an Act of the year 1784, which recited the Act of 1778, it was enacted that in future, in order to prevent any bad seed, which should be imported, from being sold for sowing, whenever any two of the said three persons

persons summoned by the collector or other officer, pursuant to the provision in the said Act, to view any flax-seed or hemp-seed, should not report their opinion that the same was of sound quality, or fit for sowing, the said seed, and the casks in which the same was contained, should be detained in the King's stores till the first day of July next following the importation thereof, and should then be delivered without fee or reward to the importer, upon his giving sufficient security to the collector or other officer, that the whole of the said flax-seed should be exported or made into oil in the said kingdom before the first day of February next following; and if the importer or importers should not give such security before the twenty-ninth day of September next following the first day of July as aforesaid, such flax-seed or hemp-seed, and the cask or casks wherein the same was contained, should be sold by public auction to the person who should offer the highest price for the same, and enter into like security; or should be publicly burned or otherwise destroyed on failure of a bidder or bidders, who should give such security.

They farther report that by an Act of the same Parliament passed in 1797, reciting that flax-seed and hemp-seed which had been regularly branded at the time of importation, as being sound and fit for sowing, had been afterwards sold or exposed to sale, although such seed might after the branding thereof, from age, damp, or other injury, have become unsound and damnified, it was enacted that it should and might be lawful for any inspector general, or inspector or other officer, acting under the trustees of the Linen Board, to examine as often as he should think necessary any cask containing flax-seed or hemp-seed, although the same should have been so branded: and if the seed contained in any such cask shall be found unsound, damnified, mixed, or in any way unfit

fit for sowing, to require security to be given that the same should not be sown or sold for sowing, but be made up into oil, or exported from the said kingdom; and if any person shall refuse or prevent any flax-seed or hemp-seed from being so examined, or should after such requisition made, and until security should be given, sell or dispose of, or suffer to be sold or disposed of in any way, any part of such seed, and should be convicted thereof upon oath before any magistrate, he or she shall forfeit the sum of twenty shillings for every bushel or part of a bushel so sold or disposed, or permitted to be sold or disposed of, and all the seed remaining, touching which such requisition shall have been made; and the cask or casks wherein the same is contained shall be forfeited.

It is stated by Mr. Charles Duffin, inspector-general of linen manufacture in Leinster, Munster, and Connaught, in his evidence, annexed to the report, that it is his duty to go round the three Provinces once a year, and as often as the Board requests, to make his report upon the growth of flax, and to inspect into the conduct of the county inspectors; that he has frequently found flax-seed, which had been branded on the quay of Dublin, and which had been imported from the Northern ports of America, very unsound and unfit for sowing, but that previous to the Act of 1797, he possessed no power to prevent its being sold for that purpose, and could only warn the people from buying it; and that he suggested this defect in 1796 to the then Chancellor of the Exchequer in Ireland, in consequence of which suggestion the Act was passed. He states that, whenever unsound seed be sown, the crops are uniformly defective, and that this was more especially apparent in 1798, when some flax-seed was sown in Ireland, before he discovered the circumstance, which had been rejected by the inspectors of Scotland. He gives it as the result of his experience, that

that the fresher the flax-seed is, the more oil there is in it, and therefore the better calculated for vegetation; the older being in general dry, and less fit for vegetating; and that when the seed is mixed, part old and part new, the crop will consequently be unequal in height, and the shorter part will in general be lost. He remarks that it not unfrequently happens that bad seed is put into hogsheads in the interior of the country, which have been branded and contained good seed on importation, and he thinks seed frequently injured by being kept four or five months in a damp storehouse. The average quantity of flax-seed imported into Ireland between 1792 and 1802, is said to be between 41 and 42,000 hogsheads annually; and he observes that every hogshead of flax-seed will sow one acre and three roods Irish measure (which is equal to one acre, one rood, and twenty-four perches English); if good seed, it will produce 84 stone on an average of rough flax fit for the hatchel, which at a moderate price would sell for 42*l.*; but in the hands of a manufacturer is of much greater value, as it employs the women and children in the autumn months preparing it for spinning, and the remainder of the year working it up into yarn. After descanting on the important difference in the crop between good and bad seed, Mr. Duffin conceives the best mode of preventing the evil arising from sowing bad or damaged seed, to be a rigid inspection on importation in the first instance, and afterwards by inspecting, in the months of January and February of every year, all the seed remaining from the importation of the preceding season; for, though American seed of the former year may produce a good crop if kept in a dry store, yet Dutch will not, unless started out of the hogshead, as the hogsheads in which Dutch seed is imported are old wine vessels, the lees of which destroy the vegetative quality of the seed; and that from Memel is even inferior to Dutch,

THE

REPERTORY

OF

ARTS, MANUFACTURES,

AND

AGRICULTURE.

No. LXX. SECOND SERIES. March 1808.

Specification of the Patent granted to WILLIAM CHAPMAN, *of the Town and County of Newcastle-upon-Tyne, Civil Engineer; for a Method or Methods of reducing the Wear, and prolonging the Duration of Ropes used in drawing of Coals or other Minerals from Pits or Shafts of Mines.*

Dated April 8, 1807.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that my method or methods of reducing the wear and prolonging the duration of ropes used in drawing coals or other minerals from pits or shafts of mines, are principally of use where great quantities are to be drawn from deep pits in a short period of time, and where steam-engines are made use of. The methods are independent of each other, and may be used either together or separately; they are simply as follows; that is to say: first, the reducing the shock arising from suddenly putting the basket or tub of coals or minerals in motion, and diminishing the

effect of any other shocks which may be received during the ascent or descent of the coals or other minerals, or of the empty baskets or vessels in which they are or may be contained; and secondly, in causing the rope to wear more equally throughout from end to end, preventing its fibres being torn or deprived of their elasticity, by the rope being kept in full stretch round the winding barrel after ceasing to suspend the weight raised.

In the deep coal-mines of Northumberland and Durham, baskets of about eight hundred weight of coals are frequently drawn up with a mean velocity exceeding ten feet *per* second, and the lifting of the coals and baskets is almost instantaneous; the shock is therefore considerable in starting the loaded basket or corf, as it is technically called, and it is also great when the loaded corf chances to strike underneath the light one, which from its size and the quantity of iron in it, generally weighs near two hundred weight; consequently as they approach each other with a velocity frequently exceeding twenty feet *per* second, the shocks they give by striking each other shorten the duration of the ropes.

My method of remedying the evil arising from these or any other sudden tensions of the rope, is to cause the pullies over which the rope passes immediately above the pit, or any pulley in the approach to it, to recede and slack out the rope on its receiving increased tension, and to return when the tension is lessened.

If pullies in the approach be used as by Figs. 4 and 5, or by any other mode, then those over the pit may be stationary as they are at present, and the moving pulley may progressively lift or lower a chain or series of weights, the whole of them equal to or exceeding the greatest gravitating resistance. On this principle various modes may be used to answer the end; but these examples are sufficient for any mechanic: where the pullies suspending the ropes over the pits

pits are made to descend or ascend according to circumstances, they may be suspended from or sustained on any thing elastic, either of metal or wood; or they may be counterpoised by a weight on a spiral, or by a series of weights capable of resisting the varying pressure on the pulley, and of giving way or receding on receiving a sudden impulse, so as to divide and reduce the effect of the shock; or the springs and weights may be combined in these and in other instances.

The explanation of Figs. 1, 2, and 3, will be sufficient to shew any mechanic the means of carrying this method into effect, and enable him to vary it according to his pleasure.

Another method of reducing the sudden shock on the ropes, and which may either be used separately or combined with the preceding, is to give motion to the rope-wheel or barrel by the intervention of strong springs, either by the axis being in two parts connected by springs and coupling bar, or by the wheel or barrel turning on an axis, and being held by springs fixed to it, which on any sudden shock will suffer the wheel momentarily to have its motion retarded, or to move through a lesser arc or portion of a circle than the axis which follows the uniform motion of the engine. These methods are explained in Figs. 6 and 7.

My method of causing ropes to wear more equally throughout from end to end, when employed in raising minerals up a pit or shaft where they are drawn over a sheave or pulley, to which case only it extends, differs from the ordinary method in which two separate ropes attached to the rope-barrel pass each of them over a pulley, one winding upon the rope barrel whilst the other is unwinding from it; in place of which I pass the two ends of the same rope each over its separate pulley, so that one end is at the top whilst the other is at the bottom of

the pit; and the bight or loop of the rope going to and from the pit over the two pullies is passed over a grooved wheel, or round a rope-barrel, so that when at work no part of the rope is stationary on the wheel or barrel. If the rope be only passed over a grooved wheel, it should, to prevent its slipping, be pressed or held down by one or more holding rollers, as shewn in Fig. 4. But if a barrel be used, along which the rope may travel towards both ends as it winds or unwinds, then one or more turns of it may be taken round the barrel, and holding rollers may either be used or dispensed with, as circumstances may point out.

Explanation of the Figures.

Fig. 1 (plate X.) is a ground plan. P is the pit up which the minerals are drawn; *x* and *y* are the sheaves or pullies over which the ropes pass, on which the minerals or vessels containing them are suspended; *n* is the landing place for the minerals; and B the barrel, round which the rope has one or more turns sufficient to prevent its slipping.

The above references are applicable to all the other figures.

Fig. 2 is an elevation (as seen from the side V in Fig. 1) of the pullies and frame with the machinery to reduce the effect of sudden shocks by means of the pullies *x* and *y* lowering and rising according to the tensions of the ropes passing over them. These pullies are each fixed on a separate moving frame, capable of traversing up or down the uprights of the great frame, at the head of which are *m m*, the wheels or sheaves, over which pass the chains or ropes that communicate between the moving pulley and the springs or weights that are to counterbalance the varying pressures on the pulleys *x* and *y*. In this instance springs and weights are combined.

Having

Having determined the extent of motion which the pullies are to pass through between the two extremes, one of which is when the loaded corf is just landed and the rope slackened out by reversing the motion of the engine, *viz.* the position of the pulley *y*, in which the highest of series of weights *w w* is landed over the others. The uppermost weight should barely be more than a counterbalance to the weight of the frame, pulley, wheel, and portion of rope over it, so that when the empty corf is thrown down, which it often is for a height of ten or twelve feet, it will cause the sheave to give way, by acting first upon the double springs *s s*, and then upon the uppermost of the series of weights; also in its passage down, as the rope increases in weight, it will lift more of the series of weights, so that if the loaded corf chance to strike under the light one, these weights, by returning, will ease the shock at the same time that the loaded corf by the increased resistance upon it will abate its velocity, by lifting more of the weight *w w* than it has in counterpoise at half its ascent. The pulley *x* is supposed to be near its greatest descent, which is at the moment the loaded corf receives the shock of the rope which raises it from the ground, in which it will descend any determined space, according to the distance at which the counterpoise of the whole pit-rope, and that of the pit-rope and loaded corf combined, are placed from each other, and so much further as the intensity of the shock requires; because the last of the weight may be moved from the ground, as it will be sufficient that the whole of them be superior to that of the loaded corf, and of the rope from the pulley to the bottom of the pit, inclusive of the pulley and frame.

B is the rope-barrel, which here is shewn out of its position to prevent the drawing appearing complicated; the rope

rope has one turn round the barrel, and has travelled to one end of it, R *y* being the part which has raised the corf to the top, and R *x* the other, which in raising the next corf will travel towards the opposite end of the barrel.

Fig. 3 is a side elevation of the two preceding figures, in which the letters of reference are the same.

The frames carrying the pullies *x* and *y* may have a small wheel on each end of the axis of the pulley, or small wheels on any proper part of the sliding frame, to pass up and down in a channel, so as to prevent friction.

Fig. 4 is a side elevation, and has the same references as the preceding; the only difference being, that in place of the pulley *x* descending or ascending according to the variation of the stress on the rope, the intermediate pulley to which the weights are attached ascends and descends as circumstances require, the rope passing over the pulley *o* to give it a direction for lifting the weights on *t*; and likewise, that in place of the rope-barrel a grooved wheel W is shewn, with two holding rollers H H to press it into the groove. The lower of the rollers is pressed upwards by a lever and a weight at the opposite end.

Fig. 5 is also a side elevation, in which, in place of the pulley *x* performing the necessary movements, they are produced by the retiring or advancing of the pulley *z* from or to *s*, its stationary position when the corf is landed. The drawing shews, that the frame supporting the pulley *z* moves upon a centre at *a*, and is sustained in its different positions by the chain or rope *b c*, which may either pass over a pulley at *d* and raise a series of weights, or wrap round a barrel having upon the same axis a spiral wheel sustaining a weight, which increases its power by its progressive increase of distance from the centre it moves on; or the weight may be suspended from the barrel, and the rope *b c* be

Fig. 1.

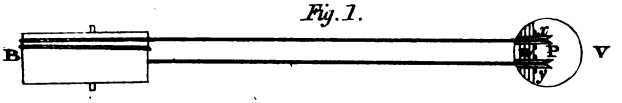


Fig. 2.

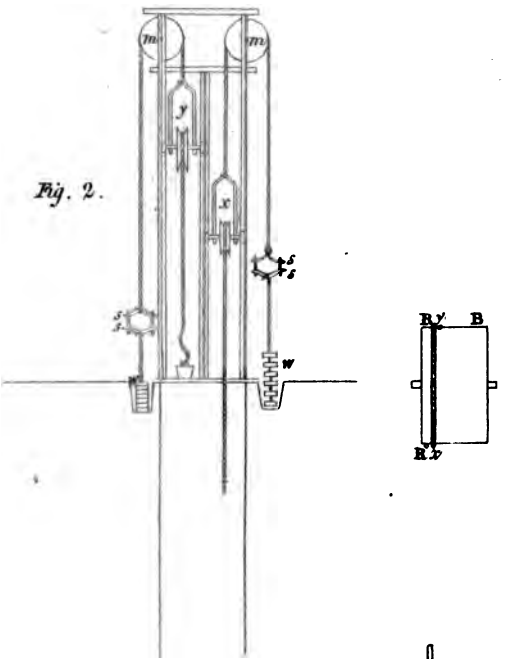
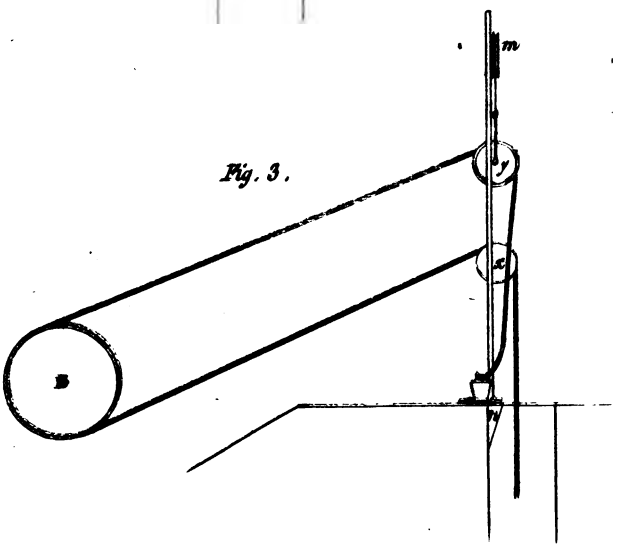


Fig. 3.



be attached to the spiral, as shewn in the plan. One of the most simple, and in many instances a sufficiently perfect method, is, to fix each of the pullies to the end of an elastic piece of timber supported in the middle, and the opposite end attached to a weight a little superior to the weight of the full corf and greatest length of rope, each end being properly tapered.

As it is ineligible to alter materially the line of suspension of corves or buckets, it is necessary, if much vertical motion be intended to be allowed to the pullies, that the rope be prevented getting out of its vertical position; which may be done by a roller or sheave below the pullies, as shewn by *x*, Fig. 5; and with this precaution the outer ends of the elastic beams may either lift a series of weights, or a weight on a spiral.

In any of the preceding instances the rope or chain which lifts a series of weights, or one weight with the intervention of a spiral, may be attached to a sheave or barrel, connected with a loaded lever on the same axis; in which case the stress on the chain or rope would be increased or diminished according as the lever became more horizontal or vertical during the motion of the barrel or sheave, which generally should be limited to less than a quarter of a circle. Also the purpose of producing a diversity of resistance on the pit-ropes, with uniformity of weight of counterbalance, may be obtained, by placing the two wheels *o* and *x*, in Fig. 4, at a considerably greater distance from each other than the diameter of the wheel *t*, on which the weight is suspended; as by this means the two parts of the rope which raise the wheel *t* will pull more and more obliquely as the latter rises.

In witness whereof, &c.

Specification

Specification of the Patent granted to JOSEPH ASTLEY, *of Borrowstounness, in Scotland, Chemist; for Improvements in the Manufacture of Sal-Ammoniac.*

Dated July 28, 1807.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Joseph Astley do hereby declare, that the nature of my said invention is described in manner following; that is to say: I prepare the salt called muriate of magnesia, or the muriate of alumine, or one or other of the metallic muriates, or any of the combinations of muriatic acid from which the acid is capable of being disengaged by heat. What I commonly employ is the muriate of magnesia, which may be procured in different ways, and very easily and economically from the mother liquor of the salt-pans, called *bittern* or *salt-oil;* the other salts contained in this being separated by evaporation and crystallisation.

I use the muriate of magnesia prepared by this or by any other process, or any of the other articles above-mentioned, either in a liquid or in a solid form. In the former way I cause animal substances of all kinds, or such vegetable or mineral substances as afford ammonia or volatile alkali by distillation, to be impregnated with liquor holding any of the said salts in solution; which liquor I use in proportions varying according to the particular kind of salt employed, the degree of concentration of the liquor, and the nature of the animal or other substances to be impregnated, the object being to obtain the acid and alkali developed in the subsequent operation in proportions approaching as nearly as possible to mutual saturation.

I afterwards dry the animal or other substances thus impregnated on a heated floor or otherwise, and either distill them

them by the heat of a furnace in a retort or still, with one or more receivers adapted to collect the products, or else burn them in a kind of furnace or kiln (which may be variously constructed), the products of the combustion being collected in chambers or receivers adapted to the purpose, which chambers or receivers must have an opening or vent to maintain the current of air necessary for the combustion.

The previous drying is not an essential part of the process, and in some cases may be dispensed with, though it will generally be found expedient.

Where I use the salt in a solid form, that is, either crystallised or dried by evaporation, the process is merely to mix it in such state with the animal or other substances, and proceed as above. But I find that the object is effected more easily and completely by using the salt in the state of solution.

Or, instead of impregnating the animal or other substances themselves with any of the saline matters above described, I cause substances of any description whatever (provided there be nothing in their nature rendering them chemically or mechanically unfit to serve as vehicles for such purpose) to be impregnated with such saline matter, and treated as above described along with the animal or other substances: the fundamental object of all these processes being to present the acid and alkali to each other in their nascent state, as they are respectively developed from the said saline matters and the animal or other substances by heat:—by which means we obtain, on the one hand, a more complete decomposition of the said salts by help of the divellent affinity of the ammonia; and we prevent in a great measure on the other hand the destruction of the alkali by combustion, which would otherwise occasion great loss in the burning of the materials. In all the processes here described the product is the same, being muriate of ammo-

nia, or sal-ammoniac, partly dry and partly in solution, which is afterwards to be crystallised and sublimed according to the ordinary processes, or which may be used for some purposes without undergoing these subsequent operations.

It may be proper to state that I do not here lay claim to the exclusive privilege of procuring muriatic acid from the salts above-mentioned by distillation, as it has been long known to chemists that several of them are decomposable by heat. My claim is to the modes of effecting this decomposition as here explained, which will be found to possess, besides the advantages already mentioned, that of avoiding the inconveniencies with which the operation of distilling the muriatic salts in question (particularly the muriate of magnesia) by themselves is always attended.

In witness whereof, &c.

Specification of the Patent granted to JOHN PHILLIPS, *of East-Stonehouse, in the County of Devon, Stone-mason and Sculptor; for Improvements in the Construction of Tinder-Boxes, whereby they will be rendered more useful than they at present are, part of which may be applied to other useful Purposes.*

Dated February 12, 1806.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Phillips do hereby declare that my said invention is described and ascertained by the drawings and descriptions thereof hereunto annexed.

EXPLANA-

Explanation of the Drawings.

Fig. 1. (Plate XI.) represents the tinder-box, the bottom of which is made as these articles generally are, except the steel, which is here fastened to the damper as at A.

Fig. 2 shews the top of the tinder-box, which may be a little turned up at the edge, as at *e e*, Fig. 4, and to which is fixed one, two, or more wires, or other proper substance, as may be found convenient, as B B, Fig. 3, which slide up and down in tubes attached to the outside of the hollow cylinder or other formed screen made of glass, horn, or other transparent substance, as C C, Fig. 3, and N N N N, Fig. 4. A bottom of tin or other substance must be attached to the same, which must be perforated as at D, Fig. 4, so as to let a candle go through the same, and rest on the top of the tinder-box at E, Fig. 4: which candle may be there confined by one, two, or more points, similar to what is called a save-all, or by a short socket, &c. The transparent screen may have a door, as shewn at F, Fig. 4, and at G, Fig. 3; or the door in the side may be omitted as at Fig. 7, and then two hollow transparent screens may be applied as P Q, the one smaller than the other, connected at the bottom so as to hold water, spirits of wine, or any transparent liquid, which will cause when the candle burns within, as at T, a steady and good light. In consequence of the transparent screen being attached to the top of the tinder-box or bottom of the candlestick, with a hole through the bottom of the same, the size of the candle to be burnt therein, as at D, Fig. 4, and U, Fig. 7, the candle is prevented from catching or setting any thing on fire which may be placed near it, and a long candle may be burnt therein by means of the wires sliding in the tubes, as at Figs. 3, 4, and 5; and the tubes S S S sliding on the wires W W W, Fig. 7, the upper part of the candle

being confined by the bottom of the transparent screen, without the possibility of its falling against the same, forming thereby a very safe candlestick, &c. for warehouses, shops, &c. &c.

The transparent screens may be mounted with tin, or any other fit substance, and cut at top, as represented at H H H, Fig. 3, or any other way that may be found proper; and a top fastened to the same with a hinge, as at I, which when turned down as here represented, any thing can be heated thereon; and when turned up, as at Figs. 4 and 5, the candle or lamp will be completely screened, so that it may be carried in the open air, &c. &c.

Fig. 5 also represents the candlestick, tinder-box, &c. with the wires shoved up the tubes, and fitted for the pocket, &c

Although it certainly will be more generally useful when the tinder-box is attached to the bottom, yet in many instances the upper parts, Figs. 2 and 3, may be used to advantage without Fig. 1. Sometimes Fig. 2 may also be omitted, and Fig. 3 only used, without its bottom perforated in the centre, as is necessary in other instances. Or Figs. 3 and 1 may be used, and only Fig. 2 omitted; and either candle or oil may be burned in either, according to what circumstances may require. A tin tube in some cases will be found useful when fastened to the top of the tinder-box or bottom of the candlestick, &c. as at K, Figs. 2 and 3, which being nearly filled with water, or a spring fixed therein, a candle put therein will rise as it burns and be always nearly at one height. Instead of tubes, wires, &c. some may be made to slide like a microscope, and then the bottom part may also be cased with glass or other transparent substance.

Fig. 6 is here inserted to shew that they may be made of any form in the bottom, &c. according as utility or fancy dictates;

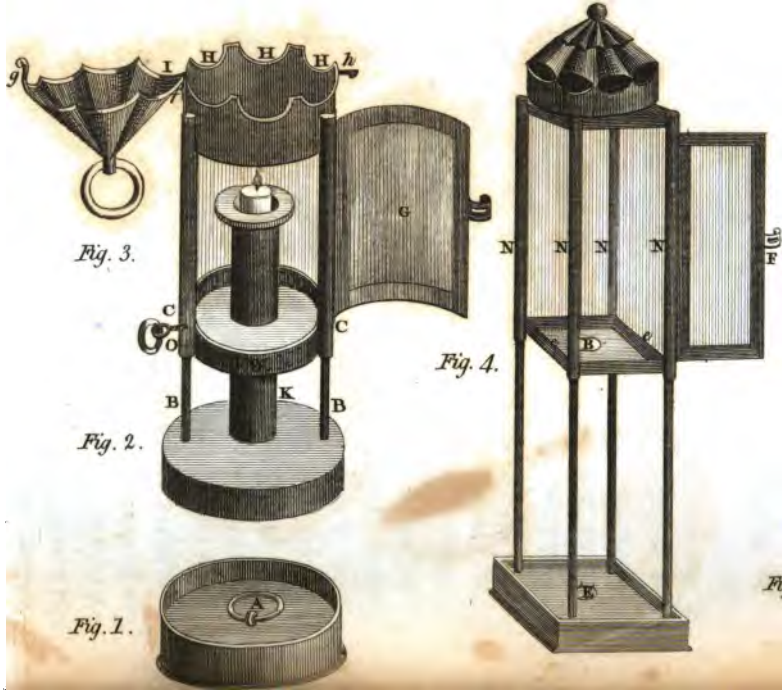


Fig. 3.

Fig. 2.

Fig. 1.

Fig. 4.

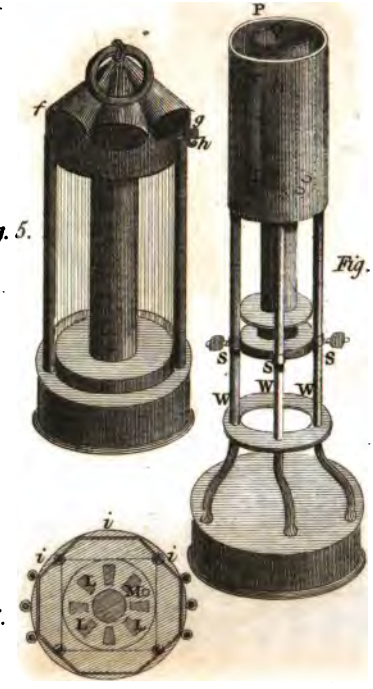


Fig. 5.

Fig. 7.

Fig. 6.

dictates; and L L L to shew that air may be admitted from the bottom in whatever quantity is found to be necessary, by means of a piece of tin or other substance, punched or cut in this or any similar form fixed on the bottom of the transparent screen, which bottom should always be punched or cut exactly similar; and a knob being fixed, as at M, it may thereby be turned so as to cover all the holes, or as much of them as is convenient. Air may be admitted also from the sides if required, as at W, Fig. 3.

Fig. 4 shews the transparent screen, drawn up to its full length, to shew that the wires and transparent screen should be nearly of one length. There should be a knob, or a kind of a head, at the top of each wire, and the bottoms of the tubes should be a little turned in, or have a small bit of solder fastened to them, or a small round bit of tin with a hole punched therein, exactly the size of the wire, but smaller than the head thereof, to prevent the wires being drawn entirely out: the wires should be a little bent, which will form a kind of a spring, and prevent their sliding too freely; or any other kind of spring may be applied that is found most useful.

O, at Fig. 3, represents a nut and screw fixed to the bottom of the transparent screen, going through the nut and one side of the tube, and meeting the wire, thereby prevents the screen from falling when a weight is fixed on the top.

The handle Fig. 5 is represented on top, but any formed handle that is found necessary may be applied to the sides, &c.; and any other ornament, &c. &c. may be added that may be thought proper. The top may be made to take off and on by means of a hinge *f f*, Figs. 3 and 5, and a kind of loop and catch *g h*, *g h*, or by any other way that is found to answer the purpose. Mirrors placed behind, as at *i i i*, Fig. 6, will have a good effect, and throw the light forward, rendering it very useful for the light of gigs, coaches, &c.

In witness whereof, &c.

OBSER-

Observations on the preceding Specification by the Patentee.

The advantages peculiar to this invention are, First, as a tinder-box, the steel will be always at hand, and having the transparent screen attached to the top of it, is another great accommodation; thereby rendering it a very useful article for the pocket, &c. &c. Secondly, as a dumb nurse and water candlestick, &c. any sized article can be heated thereby, and a candle or lamp burnt therein will give all its light to the room, &c. without any kind of danger, at the same time that it heats whatever is placed on it. Thirdly, as a lanthorn, more than three times the length of candle can be burned therein than can in any other of the same length, which will prevent the frequent necessity of the disagreeable and wasteful practice of cutting the candle; the candle is also prevented from the possibility of falling against the glass or horn, whereby of course many accidents will be prevented; neither will there be a bit of candle wasted, as is frequently the case with other lanthorns by burning down in the socket, &c.: in this it will burn and give proper light till nothing but the snuff or wick remain. Fourthly, as a fire preventing candlestick, by which is avoided the danger of sparks flying from the candle, and of curtains, cloaths, &c. communicating therewith, rendering it thereby a very safe and desirable article for shipping, warehouses, shops, manufactures, passages, bed-rooms, nurseries, and for every purpose where a candle or lamp is ever used.

Specification of the Patent granted to JOHN WILLIAMS, *of Cornhill, in the City of London, Stationer; for a new Mode of covering and inclosing all Kinds of Carriages.*

Dated December 9, 1807.

To all to whom these presents shall come, &c. Now KNOW YE, that in compliance with the said proviso, I the said John Williams do hereby declare that the nature of my said invention, and the manner in which the same is to be performed, are particularly described and ascertained as follows; that is to say; I construct a moveable frame or cover, capable of being disposed between grooves or within a cell or space in the body of the carriage, and of being drawn up by one or more straps or webs, suitably disposed, so as to act nearly in the manner commonly adopted with regard to the glasses or blinds of carriages; and I do accordingly dispose and fit up the said frame or cover in the method here mentioned and described. And I do make the said frame or cover of any fit and proper materials, and put or make therein windows or apertures when or if required; and when the materials thereof are inflexible, I do make the same of such a form or figure as shall be capable of mathematical description about a real or imaginary axis; that is to say; I do make the said form or figure spherical, spheroidal, cylindrical, or of such other description as shall in its own nature have reference to an axis. And I do make my carriage, or the grooves, spaces, or other receptacles therein, and into what the said frame or cover shall be intended to slide, of a correspondent figure, adapted to the purposes hereinbefore mentioned. And farther, I do make the said frame or cover of any desired magnitude, with ends or sides, or in such other manner as shall cover either part or the whole of the carriage in such places where the same would otherwise have

have remained open and uncovered; and I do by stops, pins, or holes in the straps or webs hereinbefore mentioned, or by other fit and obvious methods and contrivances, provide that the said frame or cover shall and may be drawn out of the said grooves, spaces or receptacles, in greater or less degrees or quantity as may be needful, and fixed in the positions so obtained. And farther, in other cases in the practice of my said invention, instead of making my cover of inflexible materials, I do make the same of small rods, bars, or pieces of wood or metal, and joined sideways together, either by tying, or sewing or glewing the same to a cloth, or otherwise to each other, as hath been done in the covers of writing-tables, and some other articles. And in this method of structure it is not necessary that the grooves, cells, spaces or receptacles in the carriage should have a figure referable to an axis as aforesaid; because the said cover may evidently be disposed in various different kinds of receptacles, which it is unnecessary to describe, because sufficiently obvious to every competent workman. And farther, I do, in other cases, make my said cover of cloth or other flexible material; and, in this last mentioned construction the disposal of the same in the body of the carriage, and the use and management of the same, will require and admit of other variations, which are also sufficiently manifest. And in every case wherein the said cover is or shall be made of materials more or less flexible, it will be needful that certain leaders or supports should be provided and made, in order that the same may be held and secured in its place when in use. And, lastly, I do declare that my said invention is applicable to all kinds of carriages or vehicles for conveyance, either by land or by water; and that the same may be made in various elegant forms of slighter or stronger materials, as may be required, and that in its own nature is very durable.

In witness whereof, &c.

On

On some Chemical Agencies of Electricity.

By HUMPHRY DAVY, *Esq. F. R. S. M. R. I. A.*

(Concluded from Page 204.)

V. On the Passage of Acids, Alkalies, and other Substances, through various attracting Chemical Menstrua, by means of Electricity.

As acid and alkaline substances, during the time of their electrical transfer, passed through water containing vegetable colours without affecting them, or apparently combining with them, it immediately became an object of inquiry, whether they would not likewise pass through chemical menstrua having stronger attractions for them; and it seemed reasonable to suppose that the same power which destroyed elective affinity in the vicinity of the metallic points, would likewise destroy it, or suspend its operation, throughout the whole of the circuit.

An arrangement was made of the same vessels and apparatus employed in the experiment on the solution of muriate of soda and sulphate of silver, page 204. Solution of sulphate of potash was placed in contact with the negatively electrified point, pure water was placed in contact with the positively electrified point, and a weak solution of ammonia was made the middle link of the conducting chain; so that no sulphuric acid could pass to the positive point in the distilled water without passing through the solution of ammonia.

The power of 150 was used: in less than five minutes it was found, by means of litmus paper, that acid was collecting round the positive point; in half an hour the result was sufficiently distinct for accurate examination.

The water was sour to the taste, and precipitated solution of nitrate of barytes.

Similar experiments were made with solution of lime, and weak solutions of potash and soda, and the results were analogous. With strong solutions of potash and soda a much longer time was required for the exhibition of the acid; but even with the most saturated alkaline lixivium it always appeared in a certain period.

Muriatic acid from muriate of soda, and nitric acid from nitrate of potash, were transmitted through concentrated alkaline menstrua under similar circumstances.

When distilled water was placed in the negative part of the circuit, and a solution of sulphuric, muriatic, or nitric acid in the middle, and any neutral salt with a base of lime, soda, potash, ammonia, or magnesia, in the positive part, the alkaline matter was transmitted through the acid matter to the negative surface, with similar circumstances to those occurring during the passage of the acid through the alkaline menstrua; and the less concentrated the solution, the greater seemed to be the facility of transmission.

I tried in this way muriate of lime with sulphuric acid, nitrate of potash with muriatic acid, sulphate of soda with muriatic acid, and muriate of magnesia with sulphuric acid; I employed the power of 150; and in less than 48 hours I gained in all these cases decided results; and magnesia came over like the rest.

Strontites and barytes passed, like the other alkaline substances, readily through muriatic and nitric acids; and, *vice versâ*, these acids passed with facility through aqueous solutions of barytes and strontites: but in experiments in which it was attempted to pass sulphuric acid through the same menstrua, or to pass barytes or strontites through this acid, the results were very different.

When

When solution of sulphate of potash was in the negative part of the circuit, distilled water in the positive part, and saturated solution of barytes in the middle, no sensible quantity of sulphuric acid existed in the distilled water after thirty hours, the power of 150 being used; after four days, sulphuric acid appeared, but the quantity was extremely minute: much sulphate of barytes had formed in the intermediate vessel; the solution of barytes was so weak as barely to tinge litmus; and a thick film of carbonate of barytes had formed on the surface of the fluid. With solution of strontites the result was very analogous, but the sulphuric acid was sensible in three days.

When solution of muriate of barytes was made positive by the power of 150, concentrated sulphuric acid intermediate, and distilled water negative, no barytes appeared in the distilled water when the experiment had been carried on for four days; but much oxymuriatic acid had formed in the positive vessel, and much sulphate of barytes had been deposited in the sulphuric acid.

Such of the metallic oxyds as were made subjects of experiment passed through acid solutions from the positive to the negative side, but the effect was much longer in taking place than in the instances of the transition of alkaline matter. When solution of green sulphate of iron was made positive, solution of muriatic acid intermediate, and water negative, in the usual arrangement, green oxyd of iron began to appear in about ten hours upon the negative connecting amianthus, and in three days a considerable portion had been deposited in the tube. Analogous results were obtained with sulphate of copper, nitrate of lead, and nitromuriate of tin.

I made several experiments on the transition of alkaline and acid matter through different neutrosaline solutions, and the results were such as might well have been anticipated.

When solution of muriate of barytes was negative, solution of sulphate of potash intermediate, and pure water positive, the power being from 150, sulphuric acid appeared in about five minutes in the distilled water; and in two hours the muriatic acid was likewise very evident. When solution of sulphate of potash was positive, solution of muriate of barytes intermediate, and distilled water negative, the barytes appeared in the water in a few minutes; the potash from the more remote part of the chain was nearly an hour in accumulating, so as to be sensible.

When the solution of muriate of barytes was positive, the solution of sulphate of potash intermediate, and distilled water negative, the potash soon appeared in the distilled water; a copious precipitation of sulphate of barytes formed in the middle vessel; but after ten hours no barytes had passed into the water.

When solution of sulphate of silver was interposed between solution of muriate of barytes on the negative side and pure water on the positive side, sulphuric acid alone passed into the distilled water; and there was a copious precipitation in the solution of sulphate of silver. This process was carried on for ten hours.

I tried several of these experiments of transition upon vegetable and animal substances with perfect success.

The saline matter exposed in contact with the metal, and that existing in the vegetable or animal substances, both underwent decomposition and transfer; and the time of the appearance of the different products at the extremities of the circuit was governed by the degree of their vicinity.

Thus when a fresh leaf-stalk of the polyanthus, about two inches long, was made to connect a positively electrified tube containing solution of nitrate of strontites, and a negatively electrified tube containing pure water, the water soon became green, and gave indications of alkaline properties,

perties, and free nitric acid was rapidly separated in the positive tube. After ten minutes the alkaline matter was examined; it consisted of potash and lime, and as yet no strontites had been carried into it: for the precipitate it gave with sulphuric acid readily dissolved in muriatic acid. In half an hour strontites, however, appeared; and in four hours it formed a very abundant ingredient of the solution.

A piece of muscular flesh of beef, of about three inches in length and half an inch in thickness, was treated in the same way as the medium of communication between muriate of barytes and distilled water. The first products were soda, ammonia, and lime; and after an hour and a quarter, the barytes was very evident. There was much free oxymuriatic acid in the positively electrified tube, but no particle of muriatic acid had passed into the negative tube, either from the muriatic solution or from the muscular fibre.

VI. *Some general Observations on these Phænomena, and on the Mode of Decomposition and Transition.*

It will be a general expression of the facts that have been detailed, relating to the changes and transitions by electricity, in common philosophical language, to say that hydrogen, the alkaline substances, the metals, and certain metallic oxyds, are attracted by negatively electrified metallic surfaces, and repelled by positively electrified metallic surfaces; and contrariwise, that oxygen and acid substances are attracted by positively electrified metallic surfaces, and repelled by negatively electrified metallic surfaces; and these attractive and repulsive forces are sufficiently energetic to destroy or suspend the usual operation of elective affinity.

It is very natural to suppose that the repellent and attractive energies are communicated from one particle to another particle of the same kind, so as to establish a conducting chain in the fluid; and that the locomotion takes place in

in consequence; and that this is really the case seems to be shewn by many facts. Thus, in all the instances in which I examined alkaline solutions through which acids had been transmitted, I always found acid in them whenever any acid matter remained at the original source. In time, by the attractive power of the positive surface, the decomposition and transfer undoubtedly become complete; but this does not affect the conclusion.

In the cases of the separation of the constituents of water, and of solutions of neutral salts forming the whole of the chain, there may possibly be a succession of decompositions and recompositions throughout the fluid. And this idea is strengthened by the experiments on the attempt to pass barytes through sulphuric acid, and muriatic acid through solution of sulphate of silver, in which, as insoluble compounds are formed and carried out of the sphere of the electrical action, the power of transfer is destroyed. A similar conclusion might likewise be drawn from many other instances. Magnesia and the metallic oxyds, as I have already mentioned, will pass along moist amianthus from the positive to the negative surface; but if a vessel of pure water be interposed, they do not reach the negative vessel, but sink to the bottom. These experiments I have very often made, and the results are perfectly conclusive; and in the case, page 258, in which sulphuric acid seemed to pass in small quantities through very weak solutions of strontites and barytes, I have no doubt but that it was carried through by means of a thin stratum of pure water, where the solution had been decomposed at the surface by carbonic acid; for in an experiment similar to these in which the film of carbonate of barytes was often removed and the fluid agitated, no particle of sulphuric acid appeared in the positive part of the chain.

It

It is easy to explain, from the general phænomena of decomposition and transfer, the mode in which oxygen and hydrogen are separately evolved from water. The oxygen of a portion of water is attracted by the positive surface, at the same time that the other constituent part, the hydrogen, is repelled by it; and the opposite process takes place at the negative surface; and in the middle or neutral point of the circuit, whether there be a series of decompositions and recompositions, or whether the particles from the extreme points only are active, there must be a new combination of the repelled matter: and the case is analogous to that of two portions of muriate of soda separated by distilled water; muriatic acid is repelled from the negative side, and soda from the positive side, and muriate of soda is composed in the middle vessel.

These facts seem fully to invalidate the conjectures of M. Ritter, and some other philosophers, with regard to the elementary nature of water, and perfectly to confirm the great discovery of Mr. Cavendish.

M. Ritter conceived that he had procured oxygen from water without hydrogen, by making sulphuric acid the medium of communication at the negative surface; but in this case sulphur is deposited, and the oxygen from the acid and the hydrogen from the water are respectively repelled, and a new combination produced.

I have attempted some of the experiments of decomposition and transfer by means of common electricity, making use of a powerful electrical machine of Mr. Nairne's construction, belonging to the Royal Institution, of which the cylinder is 15 inches in diameter, and two feet long.

With the same apparatus as that employed for decompositions by the Voltaic battery, no perceptible effect was produced by passing a strong current of electricity silently for four hours through solution of sulphate of potash.

But

But by employing fine platina points of 1-70th of an inch in diameter, cemented in glass tubes in the manner contrived by Dr. Wollaston *, and bringing them near each other, in vessels containing from three to four grains of the solution, and connected by moist asbestus, potash appeared in less than two hours round the negatively electrified point, and sulphuric acid round the positive point.

In a similar experiment sulphuric acid was transferred through moist asbestus into water; so that there can be no doubt that the principle of action is the same in common and the Voltaic electricity †.

VII. *On the general Principles of the Chemical Changes produced by Electricity.*

The experiments of Mr. Bennet had shown that many bodies brought into contact and afterwards separated, exhibited opposite states of electricity; but it is to the investiga-

* Phil. Trans. vol. xci. p. 427.

† This had been shewn, with regard to the decomposition of water, by Dr. Wollaston's important researches. By carefully avoiding sparks, I have been able to obtain the two constituents in a separate case. In an experiment in which a fine platina point cemented in glass, and connected by a single wire with the positive conductor of this machine, was plunged in distilled water in an insulated state, and the electricity dissipated into the atmosphere by means of moistened filaments of cotton, oxygen gas mixed with a little nitrogen gas was produced; and when the same apparatus was applied to the negative conductor hydrogen gas was evolved, and a minute portion of oxygen and nitrogen gases; but neither of the foreign products, the nitrogen gas in the one case, and the nitrogen and oxygen gases in the other, formed as much as 1-80th part of the volume of the gases; and there is every reason to suppose that they were derived from the extrication of common air, which had been dissolved in the water. This result, which when I first obtained it in 1803 appeared very obscure, is now easily explained; the alternate products must have been evolved at the points of the dissipation of the electricity.

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tions of Volta that a clear developement of the fact is owing; he has distinctly shown it in the case of copper and zinc, and other metallic combinations; and has supposed that it also takes place with regard to metals and fluids.

In a series of experiments made in 1801 * on the construction of electrical combinations by means of alternations of single metallic plates, and different strata of fluids, I observed that when acid and alkaline solutions were employed as elements of these instruments, the alkaline solutions always received the electricity from the metal, and the acid always transmitted it to the metal; thus, in an arrangement of which the elements were tin, water, and solution of potash, the circulation of the electricity was from the water to the tin, and from the tin to the solution of potash; but in an arrangement composed of weak nitric acid, water, and tin, the order was from the acid to the tin, and from the tin to the water.

These principles seem to bear an immediate relation to the general phænomena of decomposition and transference, which have been the subject of the preceding details.

In the simplest case of electrical action, the alkali which receives electricity from the metal would necessarily, on being separated from it, appear positive, whilst the acid under similar circumstances would be negative; and these bodies having respectively, with regard to the metals, that which may be called a positive and a negative electrical energy, in their repellent and attractive functions seem to be governed by laws the same as the common laws of electrical attraction and repulsion; the body possessing the positive energy being repelled by positively electrified surfaces, and attracted by negatively electrical surfaces; and the body possessing the negative energy following the contrary order.

* See Phil. Trans. vol. xci. p. 397.

I have made a number of experiments with the view of elucidating this idea, and of extending its application; and in all cases they have tended to confirm the analogy in a remarkable manner.

Well burned charcoal water and nitric acid, the same substance water and solution of soda, made respectively elements of different electrical combinations, became distinctly active when twenty alternations were put together; the positive energy being exhibited on the side of the alkali, and the negative on that of the acid. Arrangements of plates of zinc, pieces of moistened pasteboard, and moistened quicklime, to the number of forty series, likewise formed a weak electrical pile, the effect of the lime being similar to that of an alkali, but the power was soon lost.

I endeavoured, by means of very delicate instruments, to ascertain the electrical states of single insulated acid and alkaline solutions, after their contact with metals; and for this purpose I employed at different times the condensing electrometer of Mr. Cuthbertson's construction, Mr. Cavallo's multiplier, and a very sensible electrical balance, on the principle of torsion, adopted by M. Coulomb: but the effects were unsatisfactory; the circumstances of evaporation and of chemical action, and the adherence of the solutions to the surfaces of the metals employed, in most cases prevented any distinct result, or rendered the source of the electricity doubtful. I shall not enter into any details of these processes, or attempt to draw conclusions from capricious and uncertain appearances, which, as we shall immediately see, may be fully deduced from clear and distinct ones.

The alkaline and acid substances capable of existing in the dry and solid form, give by contact with the metals exceedingly sensible electricities, which require for their exhibition the gold leaf electrometer only with the small condensing plate.

When

When oxalic, succinic, benzoic or boracic acid, perfectly dry, either in powder or crystals, were touched upon an extended surface with a plate of copper insulated by a glass handle, the copper was found positive, the acid negative. In favourable weather, and when the electrometer was in perfect condition, one contact of the metal was sufficient to produce a sensible charge; but seldom more than five or six were required. Other metals, zinc and tin for instance, were tried with the same effect. And the metal received the positive charge, apparently to the same extent, whether the acid was insulated upon glass, or connected with the ground.

The solid acid of phosphorus, which had been strongly ignited, and most carefully excluded from the contact of air, rendered the insulated plate of zinc positive by four contacts; but after exposure to the atmosphere for a few minutes it wholly lost this power.

When metallic plates were made to touch dry lime, strontites, or magnesia, the metal became negative; the effect was exceedingly distinct, a single contact upon a large surface being sufficient to communicate a considerable charge. For these experiments the earths were carefully prepared; they were in powder, and had been kept for several days in glass bottles before they were used: it is essential to the success of the process that they be of the temperature of the atmosphere. In some experiments which I made upon them when cooling, after having been ignited, they appeared strongly electrical, and rendered the conductors brought in contact with them positive.

I made several experiments, in a similar manner, on the effects of the contact of potash and soda with the metals. Potash in no instance afforded a satisfactory result; its powerful attraction for water presents an obstacle probably insurmountable to the success of any trials made in the free

atmosphere. Soda, in the only case in which electricity was exhibited, affected the metal in the same way as lime, strontites, and magnesia. Upon this occasion the soda had been prepared with great care, exposed in a platina crucible for nearly an hour in a red heat, and suffered to cool in the crucible inverted over mercury; when cool it was immediately removed, and the contact made with a plate of zinc: the experiment was performed in the open air; the weather was peculiarly dry, the thermometer stood at 38° Fahrenheit, and the barometer at 30·2 inches; six contacts gave a charge to the condensing electrometer in the first trial; in the second ten were required to produce a similar effect; and after this, though two minutes only had elapsed, no further result could be obtained.

In the decomposition of sulphuric acid by Voltaic electricity the sulphur separates on the negative side. The experiments of various electricians prove, that by the friction of sulphur and metals the sulphur becomes positive and the metals negative; the same thing I find happens from the contact of an unexcited cake of sulphur and insulated metallic plates. Mr. Wilke has stated an exception to lead, as rendering sulphur negative by its friction. The results that I have obtained with lead, in trials very carefully made, are the same as those with other metals*. Sulphur, by being rubbed or struck against newly-polished lead, always

* As sulphur is a nonconductor, and easily excited by slight friction, or small changes in its temperature, some caution is required in drawing conclusions from the experiments in which it is employed. Sulphur, examined immediately after having been heated, gives a positive charge to conductors, agreeing in this respect with the alkaline substances; and a slight contact with the dry hand is sufficient to render it negative. In general, likewise, in experiments of contact, care should be taken that the metallic plate is free from electricity: well polished plates of copper and zinc will, I find, receive a negative charge from being laid on a table of common mahogany.

became

became positive. Mr. Wilke, perhaps, was misled by using tarnished lead: sulphur, I find, rubbed against litharge or lead the surface of which has been long exposed to air, becomes negative; and this exception being removed, all the facts on the subject are confirmations of the general principle *.

On the general principle oxygen and hydrogen ought to possess, with regard to the metals respectively, the negative and positive energy. This I have not been able to prove by direct experiments of contact; but the idea is confirmed by the agency of their compounds: thus I have found that solution of sulphuretted hydrogen in water acts in the electrical apparatus, composed of single plates and different strata of fluids, in the same manner as alkaline solutions; and that solution of oxymuriatic acid is more powerful in similar arrangements than solutions of muriatic acid of a higher degree of concentration; and in both these cases it is impossible to conceive the combined hydrogen and oxygen inactive. The inference, likewise, is fully warranted by the case of the solutions of alkaline hydroguretted sulphurets, which consisting principally of alkali and sulphur together in union with water, exhibit the positive energy with regard to the metals in a very high degree. In the series of experiments on Voltaic arrangements, constructed

* Concentrated solution of phosphoric acid, I find, is decomposed by Voltaic electricity: the phosphorus combines with the negatively electrified metal, and forms a phosphuret; at least this happened in the two cases that I tried with platina and copper. From all analogy it may be inferred that the electrical energy of this inflammable substance with regard to metals is the same as that of sulphur. I tried some experiments of contact upon it, but without success: Its slow combustion in the atmosphere, it is most likely, was the cause of the failure; but even in gases not containing free or loosely combined oxygen, its evaporation would probably interfere.

with

with single plates above mentioned, I found the solutions of hydroguretted sulphurets in general much more active than alkaline solutions, and particularly active with copper, silver, and lead. And in an experiment that I made on a combination of copper, iron, and hydroguretted sulphurets of potash, in 1802, I found that the positive energy of the hydroguretted sulphurets with regard to the copper was sufficient to overpower that of the iron; so that the electricity did not circulate from the copper to the iron, and from the iron to the fluid, as in common cases, but from the copper to the hydroguretted sulphuret, and from the hydroguretted sulphuret to the iron.

All these details afford the strongest confirmation of the principle. It may be considered almost as a mere arrangement of facts; and, with some extensions, it seems capable of being generally applied.

Bodies possessing opposite electrical energies with regard to one and the same body, we might fairly conclude, would likewise possess them with regard to each other. This I have found, by experiment, is the case with lime and oxalic acid. A dry piece of lime, made from a very pure compact secondary limestone, and of such a form as to present a large smooth surface, became positively electrical by repeated contacts with crystals of oxalic acid; and these crystals placed upon the top of a condensing electrometer, and repeatedly touched by the lime, which after each contact was freed from its charge, rendered the gold leaves negatively electrical. The tendency of the mere contacts of the acid and alkali with the metal would be to produce opposite effects to those exhibited, so that their mutual agency must have been very energetic.

It will not certainly be a remote analogy to consider the other acid and alkaline substances generally, and oxygen and hydrogen as possessing similar electrical relations; and in the

the decompositions and changes presented by the effects of electricity, the different bodies naturally possessed of chemical affinities appear incapable of combining, or of remaining in combination, when placed in a state of electricity different from their natural order. Thus, as we have seen, the acids in the positive part of the circuit separate themselves from alkalies, oxygen from hydrogen, and so on; and metals on the negative side do not unite to oxygen, and acids do not remain in union with their oxyds; and in this way the attractive and repellent agencies seem to be communicated from the metallic surfaces throughout the whole of the menstruum.

VIII. *On the Relations between the Electrical Energies of Bodies, and their Chemical Affinities.*

As the chemical attraction between two bodies seems to be destroyed by giving one of them an electrical state different from that which it naturally possesses; that is, by bringing it artificially into a state similar to the other, so it may be increased by exalting its natural energy. Thus, whilst zinc, one of the most oxydable of the metals, is incapable of combining with oxygen when negatively electrified in the circuit, even by a feeble power; silver, one of the least oxydable, easily unites to it when positively electrified; and the same thing might be said of other metals.

Among the substances that combine chemically, all those, the electrical energies of which are well known, exhibit opposite states; thus, copper and zinc, gold and quicksilver, sulphur and the metals, the acid and alkaline substances, afford opposite instances; and supposing perfect freedom of motion in their particles or elementary matter, they ought, according to the principles laid down, to attract each other in consequence of their electrical powers. In the present state of our knowledge, it would be useless to attempt to speculate

speculate on the remote cause of the electrical energy, or the reason why different bodies, after being brought into contact, should be found differently electrified; its relation to chemical affinity is, however, sufficiently evident. May it not be identical with it, and an essential property of matter?

The coated glass plates of Beccaria strongly adhere to each other when oppositely charged, and retain their charges on being separated. This fact affords a distinct analogy to the subject; different particles in combining must still be supposed to preserve their peculiar states of energy.

In the present early stage of the investigation, it would be improper to place unbounded confidence in this hypothesis; but it seems naturally to arise from the facts, and to coincide with the laws of affinity, so ably developed by modern chemists; and the general application of it may be easily made.

Supposing two bodies, the particles of which are in different electrical states, and those states sufficiently exalted to give them an attractive force superior to the power of aggregation, a combination would take place which would be more or less intense according as the energies were more or less perfectly balanced; and the change of properties would be correspondently proportional.

This would be the simplest case of chemical union. But different substances have different degrees of the same electrical energy in relation to the same body: thus the different acids and alkalies are possessed of different energies with regard to the same metal; sulphuric acid, for instance, is more powerful with lead than muriatic acid, and solution of potash is more active with tin than solution of soda. Such bodies likewise may be in the same state or repellent with regard to each other, as apparently happens in the cases just mentioned; or they may be neutral; or they may be in opposite

positive or attracting states, which last seems to be the condition of sulphur and alkalies that have the same kind of energy with regard to metals.

When two bodies repellent of each other act upon the same body with different degrees of the same electrical attracting energy, the combination would be determined by the degree: and the substance possessing the weakest energy would be repelled; and this principle would afford an expression of the causes of elective affinity, and the decompositions produced in consequence.

Or where the bodies having different degrees of the same energy, with regard to the third body, had likewise different energies with regard to each other, there might be such a balance of attractive and repellent powers as to produce a triple compound; and by the extension of this reasoning, complicated chemical union may be easily explained.

Numerical illustrations of these notions might be made without difficulty, and they might be applied to all cases of chemical action; but in the present state of the inquiry, a great extension of this hypothetical part of the subject would be premature.

The general idea will, however, afford an easy explanation of the influence of affinity by the masses of the acting substances, as elucidated by the experiments of M. Berthollet; for the combined effect of many particles possessing a feeble electrical energy, may be conceived equal or even superior to the effect of a few particles possessing a strong electrical energy: and the facts mentioned, page 108, confirm the supposition: for concentrated alkaline lixivia resist the transmission of acids by electricity much more powerfully than weak ones.

Allowing combination to depend upon the balance of the natural electrical energies of bodies, it is easy to conceive that a *measure* may be found of the artificial energies, as to intensity and quantity produced in the common electrical

machine, or the Voltaic apparatus, capable of destroying this equilibrium; and such a measure would enable us to make a scale of electrical powers corresponding to degrees of affinity.

In the circuit of the Voltaic apparatus, completed by metallic wires and water, the strength of the opposite electricities diminishes from the points of contact of the wires toward the middle point in the water, which is necessarily neutral. In a body of water of considerable length it probably would not be difficult to assign the places in which the different neutral compounds yielded to, or resisted, decomposition. Sulphate of barytes, in all cases that I tried, required immediate contact with the wire: solution of sulphate of potash exhibited no marks of decomposition with the power of 150, when connected in a circuit of water ten inches in length, at four inches from the positive point; but when placed within two inches, its alkali was slowly repelled, and its acid attracted *.

Whenever bodies brought by artificial means into a high state of opposite electricities are made to restore the equilibrium, heat and light are the common consequences. It is perhaps an additional circumstance in favour of the theory, to state, that heat and light are likewise the result of all in-

* In this experiment, the water was contained in a circular glass basin two inches deep, the communication was made by pieces of amianthus of about the eighth of an inch in breadth. The saline solution filled a half ounce measure, and the distance between the solution and the water, at both points of communication, was a quarter of an inch. I mention these circumstances because the quantity of fluid and the extent of surface materially influence the result in trials of this kind. Water included in glass syphons forms a much less perfect conducting chain than when diffused upon the surface of fibrous non-conducting substances of much smaller volume than the diameter of the syphons. I attempted to employ syphons in some of my first experiments; but the very great inferiority of effect as compared with that of amianthus made me altogether relinquish the use of them.

tense

tense chemical action. And as in certain forms of the Voltaic battery, where large quantities of electricity of low intensity act, heat is produced without light; so in slow combinations there is an increase of temperature without luminous appearances.

The effect of heat, in producing combination, may be easily explained according to these ideas. It not only often gives more freedom of motion to the particles, but in a number of cases it seems to exalt the electrical energies of bodies; glass, the tourmalin, sulphur, all afford familiar instances of this last species of energy.

I heated together an insulated plate of copper and a plate of sulphur, and examined their electricities as their temperature became elevated: these electricities, scarcely sensible at 56° Fahrenheit to the condensing electrometer, became at 100° Fahrenheit capable of affecting the gold leaves without condensation; they increased in a still higher ratio as the sulphur approached towards its point of fusion. At a little above this point, as is well known from the experiments of the Dutch chemists, the two substances rapidly combine, and heat and light are evident.

Similar effects may be conceived to occur in the case of oxygen and hydrogen, which form water, a body apparently neutral in electrical energy to most other substances: and we may reasonably conclude that there is the same exaltation of power in all cases of combustion. In general, when the different energies are strong and in perfect equilibrium, the combination ought to be quick, the heat and light intense, and the new compound in a neutral state. This would seem to be the case in the instance just quoted; and in the circumstances of the union of the strong alkalies and acids. But where one energy is feeble and the other strong, all the effects must be less vivid; and the compound, instead of being neutral, ought to exhibit the excess of the stronger energy.

This last idea is confirmed by all the experiments which I have been able to make on the energies of the saline compounds with regard to the metals. Nitrate and sulphate of potash, muriate of lime, oxymuriate of potash, though repeatedly touched upon a large surface by plates of copper and zinc, gave no electrical charge to them; subcarbonate of soda and borax, on the contrary, gave a slight negative charge, and alum and superphosphate of lime a feeble positive charge.

Should this principle on further enquiry be found to apply generally, the degree of the electrical energies of bodies, ascertained by means of sensible instruments, will afford new and useful indications of their composition.

IX. *On the Mode of Action on the Pile of Volta, with experimental Elucidations.*

The great tendency of the attraction of the different chemical agents, by the positive and negative surfaces in the Voltaic apparatus, seems to be to restore the electrical equilibrium. In a Voltaic battery, composed of copper, zinc, and solution of muriate of soda, all circulation of the electricity ceases, the equilibrium is restored if copper be brought in contact with the zinc on both sides; and oxygen and acids, which are attracted by the positively electrified zinc, exert similar agencies to the copper, but probably in a slighter degree, and being capable of combination with the metal, they produce a momentary equilibrium only.

The electrical energies of the metals with regard to each other, or the substances dissolved in the water, in the Voltaic and other analogous instruments, seem to be the causes that disturb the equilibrium, and the chemical changes the causes that tend to restore the equilibrium; and the phænomena most probably depend on their joint agency.

In the Voltaic pile of zinc, copper, and solution of muriate of soda, in what has been called its condition of electrical tension, the communicating plates of copper and zinc

are in opposite electrical states. And with regard to electricities of such very low intensity, water is an insulating body: every copper-plate consequently produces by induction an increase of positive electricity upon the opposite zinc plate; and every zinc plate an increase of negative electricity on the opposite copper-plate; and the intensity increases with the number, and the quantity with the extent of the series.

When a communication is made between the two extreme points, the opposite electricities tend to annihilate each other; and if the fluid medium could be a substance incapable of decomposition, the equilibrium, there is every reason to believe, would be restored, and the motion of the electricity cease. But solution of muriate of soda being composed of two series of elements possessing opposite electrical energies, the oxygen and the acid are attracted by the zinc, and the hydrogen and the alkali by the copper. The balance of power is momentary only; for solution of zinc is formed, and the hydrogen disengaged. The negative energy of the copper and the positive energy of the zinc are consequently again exerted, enfeebled only by the opposing energy of the soda in contact with the copper, and the process of electromotion continues, as long as the chemical changes are capable of being carried on.

This theory in some measure reconciles the hypothetical principles of the action of the pile adopted by its illustrious inventor, with the opinions concerning the chemical origin of Galvanism, supported by the greater number of the British philosophers; and it is confirmed and strengthened by many facts and experiments.

Thus the Voltaic pile of 20 pairs of plates of copper and zinc exhibits no permanent electromotive power when the connecting fluid is water free from air *; for this substance

* The experiments proving this fact, and the other analogous facts in this page, may be seen detailed in Nicholson's Journal, 4to. vol. iv. p. 298 and 393; and Phil. Mag. vol. x. p. 40.

does

does not readily undergo chemical change, and the equilibrium seems to be capable of being permanently restored through it. Concentrated sulphuric acid, which is a much more perfect conductor, is equally inefficient, for it has little action upon zinc, and is itself decomposed only by a very strong power. Piles, containing as their fluid element either pure water or sulphuric acid, will undoubtedly give single shocks, and this effect is connected with the restoration of the equilibrium disturbed by the energies of the metals; but when their extreme plates are connected there is no exhibition, as in usual cases of electromotion. Water containing loosely combined oxygen is more efficient than water containing common air, as it enables oxyd of zinc to be formed more rapidly, and in larger quantities. Neutrosaline solutions, which are at first very active, lose their energy in proportion as their acid arranges itself on the side of the zinc, and their alkali on that of the copper; and I have found the powers of a combination nearly destroyed from this cause very much revived, merely by agitating the fluids in the cells, and mixing their parts together. Diluted acids, which are themselves easily decomposed, or which assist the decomposition of water, are above all other substances powerful; for they dissolve the zinc, and furnish only a gaseous product to the negative surface, which is immediately disengaged.

There are other experiments connected with very striking results, which offer additional reasons for supposing the decomposition of the chemical menstrua essential to the continued electromotion in the pile.

As when an electrical discharge is produced by means of small metallic surfaces in the Voltaic battery, (the opposite states being exalted), sensible heat is the consequence, it occurred to me, that if the decomposition of the chemical agents was essential to the balance of the opposed electricities, the effect, in a saline solution, of this decomposition,

and

and of the transfer of the alkali to the negative side, and of the acid to the positive side, ought, under favourable circumstances, to be connected with an increase of temperature.

I placed the gold cones, which have been so often mentioned, in the circuit of the battery with the power of 100; I filled them with distilled water, and connected them by a piece of moistened asbestus, about an inch in length and one-sixth of an inch diameter; I provided a small air-thermometer capable of being immersed in the gold cones, expecting (if any) only a very slight change of temperature; I introduced a drop of solution of sulphate of potash into the positive cone; the decomposition instantly began: potash passed rapidly over into the negative cone, heat was immediately sensible; and in less than two minutes the water was in a state of ebullition.

I tried the same thing with a solution of nitrate of ammonia, and in this instance the heat rose to such an intensity as to evaporate all the water, in three or four minutes, with a kind of explosive noise; and at last actual inflammation took place, with the decomposition and dissipation of the greatest part of the salt*.

That the increase of the conducting power of the water by the drop of saline solution had little or nothing to do with the effect, is evident from this circumstance. I introduced a quantity of strong lixivium of potash into the cones, and likewise concentrated sulphuric acid, separately, which are better conductors than solutions of the neutral salts; but there was very little sensible effect.

The same principles will apply to all the varieties of the electrical apparatus, whether containing double or single

* In this process ammonia was rapidly given off from the surface of the negative cone, and nitrous acid from that of the positive cone, and a white vapour was produced by their combination in the atmosphere above the apparatus.

plates;

plates; and if the ideas developed in the preceding sections be correct, one property operating under different modifications is the universal cause of their activity.

X. *On some general Illustrations and Applications of the foregoing Facts and Principles, and Conclusions.*

The general ideas advanced in the preceding pages are evidently directly in contradiction to the opinion advanced by Fabroni, and which, in the early stage of the investigation, appeared extremely probable, namely, that chemical changes are the primary causes of the phænomena of Galvanism.

Before the experiments of M. Volta on the electricity excited by the mere contact of metals were published, I had to a certain extent adopted this opinion; but the new facts immediately proved that another power must necessarily be concerned; for it was not possible to refer the electricity exhibited by the opposition of metallic surfaces to any chemical alterations, particularly as the effect is more distinct in a dry atmosphere, in which even the most oxydable metals do not change, than in a moist one, in which many metals undergo chemical alteration.

Other facts likewise soon occurred demonstrative of the same thing. In the Voltaic combination of diluted nitrous acid, zinc and copper, as is well known, the side of the zinc exposed to the acid is positive. But in combinations of zinc, water and diluted nitric acid, the surface exposed to the acid is negative; though if the chemical action of the acid on the zinc had been the cause of the effect, it ought to be the same in both cases.

In mere cases of chemical change likewise electricity is never exhibited. Iron burnt in oxygen gas, properly connected with a condensing electrometer, gives no charge to it during the process. Nitre and charcoal deflagrated in communication with the same instrument do not by their agencies in the slightest degree affect the gold leaves. Solid pure

potash

potash and sulphuric acid made to combine in an insulated platina crucible produce no electrical appearances. A solid amalgam of bismuth and a solid amalgam of lead become fluid when mixed together: the experiment, I find, is connected with a diminution of temperature, but with no exhibition of electrical effects. A thin plate of zinc, after being placed upon a surface of mercury, and separated by an insulating body, is found positive, the mercury is negative: the effects are exalted by heating the metals; but let them be kept in contact sufficiently long to amalgamate, and the compound gives no signs of electricity. I could mention a great number of other instances of pure chemical action, in which I have used all the means in my power to ascertain the fact, and the result has been constantly the same. In cases of effervescence, indeed, particularly when accompanied by much heat, the metallic vessels employed become negative, but this is a phænomenon connected with evaporation, the change of state of a body independent of chemical change, and is to be referred to a different law *.

* The change of the capacities of bodies in consequence of the alteration in their volumes or states of existence by heat, is a continually operating source of electrical effects; and, as I have hinted before, it often interferes with the results of experiments on the electrical energies of bodies as exhibited by contact. It is likewise probably one of the sources of the capricious results of experiments of friction, in which the same body, according as its texture is altered, or its temperature changed, assumes different states with regard to another body. Friction may be considered as a succession of contacts, and the natural energies of bodies would probably be accurately exhibited by it, if the unequal excitation of heat or its unequal communication to the different surfaces did not interfere by altering unequally their electrical capacities: Of the elements of flint glass, silex is slightly negative with regard to the metals, the soda is positive; and in contacts of glass with metals I find it exhibits the excess of the energy of the alkali: the case, as is well known, is the same in friction; the amalgam of the common machine is essential to its powerful excitation.

I mentioned the glass plates of Beccaria as affording a parallel to the case of combination in consequence of the different electrical states of bodies. In Guyton de Morveau's experiments on cohesion, the different metals are said to have adhered to mercury with a force proportional to their chemical affinities. But the other metals have different electrical energies, or different degrees of the same electrical energy with regard to this body; and in all cases of contact of mercury with another metal, upon a large surface, they ought to adhere in consequence of the difference of their electrical states, and that with a force proportional to the exaltation of those states. Iron, which M. Guyton found slightly adhesive, I find exhibits little positive electricity after being laid upon a surface of mercury, and then separated. Tin, zinc, and copper, which adhere much more strongly, communicate higher charges to the condensing electrometer. I have had no instrument sufficiently exact to measure the differences; but it would seem that the adhesion from the difference of electrical states must have operated in these experiments*, which being proportional to the electrical energies are, on the hypothesis before stated, proportional to the chemical affinities. How far cohesion in general may be influenced or occasioned by this effect of the difference of the electrical energies of bodies, is a curious question for investigation.

Many applications of the general facts and principles to the processes of chemistry, both in art and in nature, will readily suggest themselves to the philosophical inquirer.

They offer very easy methods of separating acid and alkaline matter, when they exist in combination, either together or separately, in minerals; and the electrical powers of de-

* Amalgamation undoubtedly must have interfered; but the general result seems to have been distinct.

composition

composition may be easily employed in animal and vegetable analysis.

A piece of muscular fibre, of two inches long and half an inch in diameter, after being electrified by the power of 150 for five days, became perfectly dry and hard, and left on incineration no saline matter. Potash, soda, ammonia, lime, and oxyd of iron, were evolved from it on the negative side, and the three common mineral acids and the phosphoric acid were given out on the positive side.

A laurel leaf treated in the same manner, appeared as if it had been exposed to a heat of 500° or 600° Fahrenheit, and was brown and parched. Green colouring matter, with resin, alkali, and lime, appeared in the negative vessel; and the positive vessel contained a clear fluid, which had the smell of peach blossoms; and which, when neutralized by potash, gave a blue-green precipitate to solution of sulphate of iron; so that it contained vegetable prussic acid.

A small plant of mint, in a state of healthy vegetation, was made the medium of connection in the battery, its extremities being in contact with pure water; the process was carried on for 10 minutes: potash and lime were found in the negatively electrified water, and acid matter in the positively electrified water, which occasioned a precipitate in solutions of muriate of barytes, nitrate of silver, and muriate of lime. This plant recovered after the process: but a similar one, that had been electrified for four hours with like results, faded and died *. The facts shew that the electrical

* Seeds, I find, when placed in pure water in the positive part of the circuit, germinate much more rapidly than under common circumstances; but in the negative part of the circuit they do not germinate at all. Without supposing any peculiar effects from the different electricities which however may operate, the phænomenon may be accounted for from the saturation of the water near the positive metallic surface with oxygen, and of that near the negative surface with hydrogen.

powers of decomposition act even upon living vegetable matter; and there are some phænomena which seem to prove that they operate likewise upon living animal systems. When the fingers, after having been carefully washed with pure water, are brought in contact with this fluid in the positive part of the circuit, acid matter is rapidly developed, having the characters of a mixture of muriatic, phosphoric, and sulphuric acids: and if a similar trial be made in the negative part, fixed alkaline matter is as quickly exhibited.

The acid and alkaline tastes produced upon the tongue, in Galvanic experiments, seem to depend upon the decomposition of the saline matter contained in the living animal substance, and perhaps in the saliva.

As acid and alkaline substances are capable of being separated from their combinations in living systems by electrical powers, there is every reason to believe that by converse methods they may be likewise introduced into the animal economy, or made to pass through the animal organs; and the same thing may be supposed of metallic oxyds; and these ideas ought to lead to some new investigations in medicine and physiology.

It is not improbable that the electrical decomposition of the neutral salts in different cases may admit of economical uses. Well burned charcoal and plumbago, or charcoal and iron, might be made the exciting powers; and such an arrangement if erected upon an extensive scale, neutrosaline matter being employed in every series, would, there is every reason to believe, produce large quantities of acids and alkalies with every little trouble or expense.

Ammonia and acids capable of decomposition undergo chemical change in the Voltaic circuit only when they are in very concentrated solution, and in other cases are merely carried to their particular points of rest. This fact may induce

duce us to hope that the new mode of analysis may lead us to the discovery of the true elements of bodies, if the materials acted on be employed in a certain state of concentration, and the electricity be sufficiently exalted. For if chemical union be of the nature which I have ventured to suppose, however strong the natural electrical energies of the elements of bodies may be, yet there is every probability of a limit to their strength: whereas the powers of our artificial instruments seem capable of indefinite increase.

Alterations of electrical equilibrium are continually taking place in nature; and it is probable that this influence, in its faculties of decomposition and transference, considerably interferes with the chemical alterations occurring in different parts of our system.

The electrical appearances which precede earthquakes and volcanic eruptions, and which have been described by the greater number of observers of these awful events, admit of very easy explanation on the principles that have been stated.

Besides the cases of sudden and violent change, there must be constant and tranquil alterations in which electricity is concerned, produced in various parts of the interior strata of our globe.

Where pyritous strata and strata of coal-blende occur, where the pure metals or the sulphurets are found in contact with each other, or any conducting substances, and where different strata contain different saline menstrua, electricity must be continually manifested; and it is very probable, that many mineral formations have been materially influenced, or even occasioned by its agencies.

In an experiment that I made of electrifying a mixed solution of muriates of iron, of copper, of tin, and of cobalt, in a positive vessel, distilled water being in a negative vessel, all the four oxyds passed along the asbestus, and into the

the negative tube, and a yellow metallic crust formed on the wire, and the oxyds arranged themselves in a mixed state round the base of it.

In another experiment, in which carbonate of copper was diffused through water in a state of minute division, and a negative wire placed in a small perforated cube of zeolite in the water, green crystals collected round the cube; the particles not being capable of penetrating it.

By a multiplication of such instances the electrical power of transference may be easily conceived to apply to the explanation of some of the principal and most mysterious facts in geology.

And by imagining a scale of feeble powers, it would be easy to account for the association of the insoluble metallic and earthy compounds, containing acids.

Natural electricity has hitherto been little investigated, except in the case of its evident and powerful concentration in the atmosphere.

Its slow and silent operations in every part of the surface will probably be found more immediately and importantly connected with the order and economy of nature; and investigations on this subject can hardly fail to enlighten our philosophical systems of the earth; and may possibly place new powers within our reach.

Explanation of the Figures. Plate IX.

Fig. 1, Represents the agate cups.

Fig. 2, Represents the gold cones.

Fig. 3, Represents the glass tubes, and their attached apparatus.

Fig. 4, Represents the two glass tubes, with the intermediate vessel.

In all the figures AB denote the wires, rendered one positively, the other negatively electrical; and C the connecting pieces of moistened amianthus.

Account

Account of the Methods of making Bricks.

By Mr. JAMES MALCOLM.

(Concluded from Page 236.)

THE excellency of bricks consists chiefly in the first and last operation; for bricks made of good earth, and well tempered, become solid and ponderous, and therefore will take up a longer time in drying and burning than our common bricks seem to require. It is also to be observed that the well drying of bricks, before they are burned, prevents cracking and crumbling in their burning; for when the bricks are too wet, the parts are prevented from adhering together. The best way of ordering the fire is, to make it gentle at first, and increase it by degrees as the bricks grow harder. If those several operations were properly and duly attended to, we should not see such immense waste, and so great a profusion of unburnt and half-burnt bricks, called place bricks, as we constantly find on the outsides of our modern clamps. For want of due precaution the fire never reaches them in an equable degree, and therefore they ought to be totally disregarded and laid aside; but modern ingenuity, and the tricks of the builders, have found out a mode of using them, less objectionable to be sure than if they were consigned to the outside walls, though properly they are not fit to be used any where. It is necessary that the public should be informed, that these place bricks are now made use of in the inside walls of houses of every denomination, from the hut to the palace; and that they are soft, subject to very quick decay, and wherever wet can at all get to them, they moulder away with great rapidity; nor is this the only objection to them; they are subject to be acted upon by every change of the weather, so that the walls become

come damp, and the plastering discoloured, causing the bond timbers and plates to rot; and for want of equal solidity with the external bricks, the walls crack, the timbers swag, because the bearing on them cannot be then any where equally poised.

The dampness which so often affects the inside walls is attempted to be palliated, or removed, by the introduction of what is called battening, whereby an opening or cavity is left between the brick-work or plastering; but whoever has attentively observed the result of this invention, which in very many instances has fallen to my lot to notice, will see that the damp arising from these bricks engenders mould and is visible on the frame of the wood used in the battening; this mould is no doubt the secondary cause of the dry rot, since the origin must be in the bricks themselves.

That this is the case may be deduced from this fact, that wherever a quantity of those bricks is heaped up together for any length of time, they will upon separation be found to have their bases covered with a fine white net-work, especially those which are nearest the bottom. Hard burnt sound bricks never have this net work grow upon them, let them lay as long as they may in any situation. This net work then is the plantulæ of mould. The origin and increase of mould is nearly in proportion to the heat of the atmosphere; its appearance and vegetation are never more sudden than during the summer, and the reason seems to be, that the heat of the weather necessarily draws out the redundant moisture from the bricks, for want of a due circulation of air. This moisture attaches itself to the outside of the bricks, and there remains, the heat not being sufficient to dry it up, but enough perhaps to produce a degree of warmth; it enters into a slow but certain process of fermentation; and, passing through a state of acidity to putrefaction, is of itself sufficient to engender mould. Sometimes it is very long

long before mould is produced on particular substances, either from the absence of the seed, or the substance not being well adapted for its vegetation; while in others, the seed has been known to vegetate in three hours. The mould from being first white turns yellowish, and at last blackens. As it approaches a state of maturity, a kind of black dust falls from it, which is the seed of the plantulæ; a quantity of this dust constitutes the powder, which blackens the hand when touched. As this dust and seed is so fine and infinite, it spreads with a rapidity equal to the state and condition of the substances which may be fit to receive it, and hence may attack a whole building, and become the means of endangering and eventually destroying the most superb edifice.

Another fact will confirm this reasoning. In pulling down the most ancient houses not an atom of dry rot has been visible, but merely a decay in the timbers occasioned by age, because the bricks inside and out were alike hard and sound: but where modern ones have been erected on the old sites, a very few years have been sufficient to prove, that symptoms of dry rot have manifested themselves in the basement, from the great degree of humidity which prevails there.

If such bricks therefore are not timely removed, all the art of man cannot prevent the effects of the dry rot: it is the same with certain sorts of stone, which are always damp, be the weather what it may, and there the dry rot makes the greater havock.

Besides the bricks made at the places beforementioned, there are some made at Tooting, of common stocks, at Mr. Brodie's; at Croydon, by Mr. Cooper; some very good white bricks, and geometrical tiles, at Reigate, by Mrs. Lucock; at Send Turnpike, by Mr. Daws; at Brook, in the parish of Witley, by Mr. Mitchell; at Wilderwick, by Mr. Awery. The common computation is, that every acre

will yield one million of bricks, in every foot in depth, which also includes ashes that are usually mixed with it. In general our fields are shallow with a bottom of gravel, yet I think they will average nearly five feet, though I believe we have none that will run 10, 12, or more feet as about Kingsland, at least such is my information, as well as observation.

There is a duty imposed on bricks by three Acts of Parliament, of 5*s.* for every 1000 of bricks, payable by the maker, who is allowed 10 for every 100 when charged in the field, before burned, in compensation for all waste, loss, or damages; and the duty must be paid in six weeks. Also,

	s.	*d.*
For every 1000 plain tiles	4	10
For every 1000 pan tiles, or ridge tiles	12	10
For every 100 paving tiles, not exceeding 10 inches square	2	5
If exceeding 10 inches, an additional duty of	4	10
For every 1000 tiles, other than the above, by whatever name known	4	10

The price is as under:

	s.	*s.*
Best washed malm or marl stocks ..	50 to 60	per 1000
Seconds	40 to 50	
Picked grey stocks	30 to 36	
Common ditto	26 to 30	
Place ditto	21 to 24	
White bricks	64	
White geometrical tiles	64	
Red tiles	40	

MANUFACTURE.

Bricks are made by the thousand, as the most satisfactory mode between master and man; and a handy man can

mould in one day, *viz.* from five in the morning until eight at night, 5000. To assist him in the preparation of the soil, &c. from the heap (which is usually dug after the season for brick making is over and laid up) there is generally a gang consisting of six persons; one man (but sometimes a woman) tempers and prepares the soil, which is done with a hoe made long, in the shape of a mattock, a shovel, scoop, a thick plank or board, and a cuckhold; with the hoe he pulls down the soil from the great heap, which is chopped backwards with the shovel, to turn it as often as may be necessary, to mix and thoroughly incorporate the ashes and soil together (because it is to be understood that at the time the soil is dug out, and made into this heap, a layer of coal ashes is alternately placed between a layer of soil, as often and in such quantities in each layer as the quality of the soil and other circumstances may make necessary.) The scoop is used to throw water over this portion that is pulled down with the hoe, in order that it may become more and more in a tempering state, more soft and ductile; and with the board he kneads it together, over which a certain quantity of sand is thrown, and it is then covered with pieces of sacking or matting to keep the sun and air from it. A boy of 10 or 12 years of age scoops or cuts off a slice with an instrument or shovel having a short handle, and the blade of it made concave, called a cuckhold, which he brings on his arms to the moulding table, which is placed under a moveable shed, upon which a girl of the same age rolls out a lump somewhat bigger than will fit the mould, the table having been previously strewed with sand. The moulder, after dipping his mould into dry sand placed at one corner of his table, throws the lump prepared by the girl into the mould, and with a flat smooth stick about eight inches long, previously dipped in a pan of water, strikes off the surplus soil; he then immediately turns out the contents of the mould upon a stand or board of the same size with

the brick. A boy takes it from thence, and places it on a light barrow, with a lattice-work frame fixed over the frame of a long barrow, at about three feet high above the wheel, and reduced to about 18 inches in height towards the handles, forming an inclined plane. The new made bricks are placed on this lattice frame, and over them sand is thrown in sufficient quantities to prevent their adhering to each other, as well as to prevent in a certain degree their cracking in drying while on the hacks. A girl wheels the barrow to the hacks, and places them with great regularity and dispatch one above the other, a little diagonally, in order to give a free passage to the air. Each hack is made wide enough for two bricks, to be placed edgways across, with a passage between the heads of each brick; they are usually made eight bricks high, the bottom bricks at the end of each hack are usually old ones.

In showery weather, wheat or rye straw is carefully laid over the bricks that are drying on these hacks, to keep them as free from wet as possible: for the brick-makers do not here, as in places more distant from the metropolis, go to the expense of roofed coverings, or long sheds, which from the extent of one of these fields would be impossible.

If the weather is tolerably fine, a few days is sufficient to make them dry enough to be turned, which is done by re-setting them more open, and turning them; and six or eight days more are required before they are fit to be put into the clamp, for kilns are not in use in this part of the county. When sufficiently dry, the clamp-maker levels the ground, generally at one end of the range of hacks nearly centrical, making the foundation of the intended clamp somewhat higher than the surrounding ground; and with place bricks, if they have any unsold, or otherwise with the driest of those just made, makes a foundation of an oblong form, beginning with the flue, which is nearly a brick wide,

and

and running straight through the clamp. In this flue dry bavins, coals, and cinders (vulgarly called breese) are laid and pressed in close, in order that the interstices between wood and coal may be properly filled up. On the sides of the flue, the bricks are placed diagonally about one inch asunder, and between each layer of bricks three or four inches of breese are strewed, and in this manner they build tier upon tier as high as the clamp is meant to be; never omitting between each layer, as well as between each brick, that is placed diagonally, to put a due portion of breese. When they have made the clamp about six feet long, another flue is made similar in every respect to the preceding, to the extent of the size of the intended clamp; provided only that the bricks are meant to be burnt off quick, which they will be in about 21 or 30 days, according as the weather may suit. But if there is no immediate hurry for the bricks, the flues are placed at about nine feet asunder, and the clamp left to burn off slowly. When fire is set to the clamp, and it burns well (the ash-hole being placed at the West end generally) the mouths are stopped with bricks, and clay laid against them; the outsides of the clamps are plastered with clay if the weather is at all precarious, or the fire burns furiously; and to the end against which addition is made to the clamp, skreens made of reeds worked into frames about six feet high, and sufficiently wide to be moved about with ease, are placed to keep off the weather; and against any particular side where wet is most prevalent. On the top of the clamp a thick layer of breese is uniformly laid.

This is the mode of manufacturing the common grey stocks for walls and common buildings; but some brick-makers, in order to mix the soil and ashes more regularly, perform it with a machine, called a clay-mill, which a horse turns round. This machine consists of a tub or tun fixed

fixed to the ground, in which is placed perpendicularly an instrument resembling a worm or screw; the soil being put in at top, is worked down by the rotary motion of the worm, and is forced out at a hole made on the side near the bottom of the tub. A man supplies the tub with fresh soil, properly moistened, while the person who supplies the moulder keeps removing that which is thus prepared, or pressed out.

Washed malms, or more properly marls, are made with still greater attention: a circular walled recess is built about four feet deep and from three to four feet wide, paved at bottom, and from 10 to 12 feet diameter, having a horse-wheel placed in the centre; the ground is raised all round it, and a platform made upon a level with the top of the recess. On this platform the horse walks, a pump is fixed into a well, as near to the platform as may be, to supply the recess with water as often as occasion may require. A harrow made to fit the recess, and thick set with long iron teeth, well loaded, is chained to the traces of the horse, who drags this after him; a man wheels a barrow full of soil previously prepared in a heap the same as for the common stocks, and shoots it regularly round the recess, he then pumps a certain quantity of water, which, by means of troughs or shoots, runs on it, and sets the horse in motion. The harrow being loaded accordingly, forces its way into the soil, admits the water into it, and by thus tearing and separating it, mixes the ingredients at the same time that it gives an opportunity for stones and other ponderous substances to subside to the bottom. The man keeps supplying it with fresh soil and water until there is a sufficient body in the recess. On one side, but as near to the recess as possible, the ground is made smooth, and dug out about 18 inches or two feet deep into a hollow square; and the soil now becomes paste, and being thereby sufficiently washed, purified, and fluid,

fluid, troughs are placed from the recess to this hollow ground, and it is ladled out with scoops or shovels into the troughs, carefully leaving the sediment at the bottom of the recess to be afterwards thrown out on the sides of it, together with stones, bones, &c. Over this hollow square or pit the fluid soil diffuses itself, where it settles of an equal thickness, and remains until wanted for use, the superfluous water being either evaporated or drained from it, by its being exposed for a certain length of time in so thin a body. When they have got a sufficient quantity of washed earth in this pit, another is made alongside of it, and so they proceed until they have got as much thus prepared as they are likely to want during the season.

The clamps for burning these better sort of bricks are individually the same with the others, but greater care is taken in not overheating the kiln, but in causing it to burn moderately, as equably and as diffusively at the same time as possible.

In the country, bricks are always burnt in kilns, whereby less waste arises, less fuel is consumed, and the bricks are sooner burnt. The bricks are first set or placed in it, and then the kiln being covered with pieces of bricks or tiles, they put in some wood to dry them with a gentle fire; and this they continue until the bricks are pretty dry, which takes up two or three days, which is known by the smoke turning from a darkish colour to a transparent smoke; they then leave off putting in wood, and proceed to make ready for burning, which is performed by putting in brush, furze, spray, heath, brake, or fern faggots, according to the scarcity or plenty of some of those articles in the neighbourhood. But before they put in any faggots they dam up the mouth or mouths of the kiln with pieces of bricks, which is called in some places shinlog, piled one upon another, and close it up with wet brick earth.

The

The shinlog they make so high that there is but just room above it to thrust in a faggot; they then proceed to put in more faggots, till the kiln and its arches look white, and the fire appears at the top of the kiln: upon which they slacken the fire for an hour, and let all cool by degrees. This they continue to do alternately, heating and slackening till the bricks be thoroughly burnt, which is usually effected in 48 hours. One of these kilns will burn 20,000 bricks, and is usually 13 feet long, by 10 feet six inches in depth, and the height about 12 feet. The walls are carried up something out of the perpendicular at top, and inclining towards each other, so that the area at the top is not more than 114 square feet; the thickness of the walls are one foot two inches.

The bricks are set on flat arches, having holes left in them something like lattice work.

Goldham observes that bricks will have double the strength if after one burning they be steeped in water and burnt afresh.

As every man who has occasion to use bricks, whether on his own estate, or on that of his landlord, cannot but be sensible of the great value of a perfectly dry house; and as I think I have shewn that it is impossible a house can be dry if bricks are used which are insufficiently burnt, such as the place bricks I have before described, he will do well to consider whether it will not be more advantageous to him in the end, to make use of no other than the very best hard sound bricks, be the colour of them what they may, and be the cost what it will. Such bricks are easily known by their sound, and by their striking fire with steel. It will be found that, besides the comfort and firmness of the building, they will be cheaper than place bricks, together with the expense of battening the walls.

In

In the interior of the county tiles are almost uniformly used for roofs of houses, and in some instances on barns; but between Dorking and Horsham a heavy but very durable sort of slate stone is used. Nearer London slates either Welch or Westmoreland prevail. As there are many persons who give the preference to tiles, it may not be amiss to know the result of a curious experiment on that subject as related by the Bishop of Llandaff.

"That sort of slate, other circumstances being the same, is esteemed the best which imbibes the least water; for the imbibed water not only increases the weight of the covering, but in frosty weather, being converted into ice, it swells and shivers the slate. This effect of frost is very sensible in tiled houses, but it is scarcely felt in slated ones; for good slate imbibes but little water, and when tiles are well glazed they are rendered in some measure, with respect to this point, similar to slate. I took a piece of Westmoreland slate, and a piece of common tile, and weighed each of them carefully; the surface of each was about 30 square inches; both the pieces were immersed in water for ten minutes, and then taken out and weighed as soon as they had ceased to drip; the tile had imbibed above a seventh part of its weight of water; and the slate had not imbibed a two-hundredth part of its weight; indeed the wetting of the slate was merely superficial. I placed both the wet pieces before the fire; in a quarter of an hour the slate was become quite dry, and of the same weight it had before it was put into the water; but the tile had lost only about 12 grains of the water it had imbibed, which was, as near as could be expected, the very same quantity which had been spread over its surface; for it was the quantity which had been imbibed by the slate, the surface of which was equal to that of the tile; the tile was left to dry in a room heated to 60 degrees, and it did not lose all the water it had imbibed in less than six days."

The finest sort of blue slate is sold at Kendal for 3*s.* 6*d.* *per* load, which comes to 1*l.* 15*s.* *per* ton, the load weighing two hundred weight.—The coarsest may be had for 2*s.* 4*d.* a load, or 1*l.* 3*s.* 4*d.* *per* ton. Thirteen loads of the finest sort will cover 42 square yards of roof, and 18 loads of the coarsest will cover the same space; so that there is half a ton less weight put upon 42 square yards of roof when the finest slate is used, than if it was covered with the coarsest kind, and the difference of the expense of the material is only 3*s.* 6*d.* To balance in some measure the advantage arising from the lightness of the finest slate, it must be remarked that it owes its lightness, not so much to any diversity in the component parts of the stone from which it is split, as to the thinness to which the workmen reduce it; and it is not able to resist violent winds so well as that which is heavier.

A common Cambridge tile weighed 37 ounces: they use at a medium 700 tiles for covering 100 square feet, or about two and a half tons of tile to 42 square yards. Hence, without including the weight of what is used in lapping over, &c. when a building is covered with copper or lead, it will be seen that 42 square yards of building will be covered by

Copper	4 cwt.
Fine slate	26
Lead	27
Coarser slate	36
Tiles	54

From the foregoing statement it is evident that the consequences arising from a covering with tiles are two fold, the first, that owing to the weight of them we are obliged to make our plates and rafters of the roof so much stouter and heavier than there is any occasion to do for slates even the coarser sort; and consequently this increased strength in the timber must add to the expense of the roof, supposing that the same thickness of wall be sufficient. Secondly, it is proved that

that from the porosity of the tile it imbibes one-seventh part of its weight, or above five ounces of water in ten minutes, and that it requires the heat of 60 degrees, which is five degrees above temperate, and six of those days, to make the tile as dry as it was before it was saturated. How much longer the tile may continue wet, during the moist winter months, if it ever dries at all upon the roofs of our houses, is a question I am not prepared to explain. But I think it appears pretty evident that such tiles lodging on timber in a state of dampness, at least for six months, must injure such timber, and together with the unburnt or place bricks in the walls cannot fail of producing an almost perpetual moisture, and make a house damp and unhealthy at nearly all seasons.

Intelligence relating to Arts, Manufactures, &c.

Observations by WILLIAM JACKSON, *Esq. Commissioner of Excise, on the* MANUFACTURE *of* SALT, *and Collection of the* DUTIES *thereon, made in Obedience to an Order of the Committee of the House of Commons appointed to consider of the Salt Duties; which Order required him to prepare and lay before the Committee a Statement of those Parts of the Laws of Excise which appeared to him to impede or interrupt, in any Respect, the Manufacture of or Trade in Salt; or which have a Tendency to discourage or distress the Fisheries; together with his Opinion on the Effects of those Laws, and also of the Practice of the Excise in the Execution of them.*

SALT is made or procured from rock-salt by the process of refining, from brine produced in natural springs, and from sea water.

The principal salt works are in and on the borders of Cheshire; at Droitwich, in Worcestershire; and on the coast of Hampshire; the whole number in England being about one hundred and eighty-three.

The process of making salt is not exactly the same at all the works; and the expense depends very much upon the strength of the brine, and the price of fuel.

The owner or proprietor of every salt-pit, or salt-work, is required to make entry with the Excise, and to provide secure warehouses for storing the salt raised or procured: the Excise Officers have at all times access to the works, and authority to inspect the premises, to examine the operations, and to take account of the salt produced.

Rock Salt,

when taken out of the pit, or mine, is deposited in a warehouse, from whence it can legally be taken in the day-time only, in the presence of the officer, and upon payment of duty, or security to deliver it at some established refinery, or manufactory of mineral alkali, or on-board for exportation.

The refineries of rock-salt in England do not in number exceed twenty-three, and the greater part of the rock-salt which is raised is taken free of duty for those refineries, or for exportation. Rock-salt is found in Cheshire, and is chiefly conveyed in flats, or other vessels, to Liverpool, from whence it is shipped for exportation, or to be sent coast-wise: it is accompanied with an Excise permit, and if intended for refining, bond is taken in treble the value of the duty for the due delivery thereof; and the bond is cancelled upon the production of a certificate of the officer of Excise testifying such delivery: the time for the production of the certificate is limited to three months.

In case of rock-salt delivered for exportation, security is given at the pits for treble the value of the duty, that the whole shall be duly shipped on-board the vessel in which it is intended to be exported; and the bond is discharged on the production of a certificate from the officer of Excise attending the shipping, which certificate is required to be produced in two months.

On

On the arrival of rock-salt at the port of exportation, and before shipped, a second bond is taken, in treble the value of the duty, for the due exportation, in which bond the commander of the vessel must join; and no certificate for the discharge of any security entered into for the exportation of rock-salt can be made out, till the exporter, or his known agent, shall have verified the exportation on oath. Refiners of salt cannot sell rock-salt unmelted.

Salt for Home Consumption

consists chiefly of three distinct sorts; *viz.* undried salt, stove-dried salt, and large-grained salt.

The operations are inspected by the officers, who have notice of the commencement and completion thereof; and who, by a sort of computation, take an account of the quantity of salt produced; which, when finished, is deposited in warehouses under the locks of the officer.

From these warehouses the salt is delivered upon notice to and in the presence of the officers; who, assisted by the proprietor's servants, weigh the same: and this is, in fact, the only opportunity which the process admits of taking a true account of the quantity of salt produced. From this account the duty is ascertained and charged; and the salt upon removal from the works is accompanied with a permit; as it likewise is if removed from any other place coastwise, or from any place whatever to London, Liverpool, Worcester, Gloucester, or Bristol. The permit specifies the name of the person from and to whom sent; the mode of conveyance, and whether by land or water; the quantity and species of salt, and for what purpose intended; and also the time for which the permit is to remain in force. The proprietor of the salt-work is required to keep, and verify on oath, a daily account of all salt delivered: and, on providing sufficient security, he has credit of nearly, or quite, seven weeks for payment of the duty.

Salt,

Salt, conveyed by canals or carried coastwise, must, on trans-shipping, if the officer requires it, be weighed; and also upon landing at the place to which it is consigned; and before delivery, the master of the vessel is required to make oath that his cargo consists of the salt only which was originally taken on-board, and that it is the same as is described in the permit.

Salt, when removed from the works, gets into consumption, in general, through the medium of dealers in the article; and it is only necessary to observe further, that salt, for which the duty has been paid, may be exported as merchandize upon bond, and the exporter is in such a case intitled to a drawback of the duty.

Salt for Exportation

can be delivered free of duty only from the warehouse at the works, or from warehouses provided expressly for the purpose of storing duty-free salt, at Bristol or Liverpool. The officer must have notice and attend the delivery, and take account of salt for exportation, as in the case of salt delivered upon duty for home consumption.

If delivered from the works, security, in treble the value of the duty, must be entered into, duly to lade the salt on-board the ship or vessel in which it is intended to be exported; and this bond is cancelled on the production of a certificate from the proper officer of the salt having been duly shipped. On re-shipping at the port of exportation, a second bond is taken, in which the master of the vessel is required to join; and this bond, if the salt be consigned to Ireland, the Isle of Man, Jersey, Guernsey, or Alderney, is discharged, on producing a certificate of the landing of the salt at the port to which it is consigned.

Salt for exportation, on removal from the works, is accompanied with a permit, as in the case of salt for home consumption; and it has been before observed, that salt for which

which the duty has been paid, upon being duly exported on bond, is entitled to a drawback of that duty.

Salt for the Fisheries

is secured and delivered under regulations similar to those observed in respect of salt for exportation. Notice of the delivery, and the attendance of the officer, is required: it is weighed in his presence, and it is accompanied on removal with a permit. Bond is given at the works; and if transshipped, to be carried coastwise, a second bond is taken, in which the master of the vessel is required to join.

The first bond is discharged upon certificate of the transshipping, and the second upon certificate of the delivery of the salt into the stock of the fish-curer, for whom it is intended. The certificate in the first case is required to be produced in one month, and in the latter in three months.

General Observations.

There are a variety of subordinate regulations intended to prevent plunder and embezzlement at the works, and fraud in the trade.

These regulations have seldom been complained of; many of them, indeed, seem to contribute in some degree to the safety and protection of the proprietors, and have little tendency to impede or obstruct the process of manufacture. The system of excise may be explained to consist in surveying and taking account of manufactures from the first and earliest state of operations; attending the same through the whole process until finished; and calculating the duty upon that account which gives the highest charge.—The process of making salt certainly does not admit of the application of this system in its fullest extent: it has, however, been applied as far as it could be done with propriety, and the effect has been an increase in the revenue, independent of the additional duties imposed.

The notices required by law at the works pending the operations, and for the delivery, as well as those required previous

previous to the shipping and landing salt, excited serious apprehensions at the commencement of the law; and a strict compliance with the law in respect of these notices may, and probably will in some instances, occasion delay and interruption; but it does not appear that those regulations have been attended with any material inconvenience to the trade, or that they have been frequently complained of. The necessity of permits for the removal of salt, and of entering into bond for the delivery of duty-free salt, seem to be the foundation of uneasiness in the minds of the trade. In fact these circumstances appear to constitute the principal grievance. For where bonds are entered into for the delivery, and permits required for the removal of specific quantities of a commodity so liable to vary in weight as salt, a discretionary power must be vested in those who superintend the execution of the laws.

Notices to Officers.

An absolute necessity for their attendance at the storing in and weighing out of salt. Weighing the salt in their presence whenever trans-shipped, and again on landing at the port or place of its destination; keeping and swearing to the daily deliveries; and obtaining permits and other official documents, must unavoidably occasion trouble and delay. It may not however be improper to observe, that if the duty were repealed, the trade could not perhaps be carried on, and the proprietor or merchant secured against plunder, without weighing the salt as frequently, and with nearly as much care, as is done at present. But the chief objections to the laws, by which the salt duty is guarded and collected, are the forfeitures and penalties, to which the merchants, manufacturers, and agents, are liable, more especially in regard of bonds and permits.

Salt removed, though but a short distance, will unquestionably vary in weight.—Stove-dried salt exposed to the air will increase in weight to a certain extent, and that increase will

will be more or less rapid in proportion as the air is more or less damp.—Salt not dried will in general decrease in weight by being exposed to a damp air, which dissolves the particles, and necessarily occasions a waste of the commodity. Thus on weighing salt removed by permit, or delivered on bond, the quantity will perhaps in every instance be found to have increased or decreased, according to the state of the salt, the time it may have remained exposed, and the dampness of the air.

It is not known that any accurate experiments have been made to what extent high-dried salt will increase in weight: the decrease in the weight of salt by exposure to the air, will always be in proportion to the particles dissolved. It is asserted in a Memorial, delivered to the Lords of his Majesty's Treasury in 1800, that high dried salt exposed in moist weather in an open flat will increase in weight two and a quarter *per cent*; and it is certain that much more considerable increases have been discovered, but not however in every case without suspicion of unfair practices.

Salt removed from the works, or carried coastwise, without a true and lawful permit, or under a false description, is forfeited, together with the vessels, cattle, and carriages employed in removing the same. Under this clause (strictly speaking) any variance between the quantity of salt removed and that specified in the permit, subjects the whole to seizure; and it does not appear that the salt laws expressly authorize the Commissioners of Excise to forego the forfeiture.

In the case of a deficiency of duty paid salt removed by permit, no fraud upon the revenue is supposed; but in the case of an excess (notwithstanding it may often happen to a certain extent without fraud or contrivance) it may be inferred that a greater quantity of salt was delivered than was charged with duty. In the case of salt delivered free of duty, whether for exportation or the fisheries, suspicion of fraud or embezzlement always arises, when deficiencies are discovered; but direct fraud is seldom imputed upon the discovery

of an excess of duty-free salt. It is nevertheless true, that an excess of such salt may be occasioned by a premeditated intention to evade the duty.

On the subject of excess or deficiency, the Excise Officers are instructed, "That if on weighing or reweighing salt, or rock-salt, removed or removing by permit, any excess shall be found over and above the quantity expressed in the permit, after making the legal allowance of half-a-pound in every two bushels of the quantity weighed or reweighed, such salt is forfeited; and unless the difference be small, and satisfactorily accounted for, it must be seized and secured and the Board immediately apprized of all the circumstances; and if on weighing any salt or rock-salt removed by permit for the purpose or with intent to be exported, or to be used in the fisheries, or rock-salt to be refined or made into mineral alkali, the quantity should be found to fall short of, or be less than the quantity expressed in the permit with which the same may be accompanied, no certificate must be granted for cancelling or discharging the bond given on the delivery of such salt or rock-salt, without the special directions of the Board, unless the difference be very small, and the reasons given for the deficiency be satisfactory to the collector or supervisor, who must be forthwith acquainted with all the circumstances of the case." It will be perceived therefore that some discretion is here left with the officers.

It may be proper to observe, that although the Officers of Excise have power to make seizures in all cases where the law creates a forfeiture, yet are those officers in no instances permitted, without the directions of the Board, to institute proceedings either for the condemnation of seizures, or for the recovery of pecuniary penalties. Every seizure and every infraction of the law must be circumstantially stated to the Commissioners, who direct either that legal proceedings shall be instituted, or that the seizure shall be restored, or the subject of complaint disregarded, as the equity of the

case may appear to require. Since the transfer of the salt-duties to the Excise, there has been no instance of proceeding against a whole cargo of salt merely on account of an increase in the quantity removed; but of excesses there have been many seizures, some of them amounting to more than five, and others to less than one *per cent.* of the quantity specified in the permit. It will perhaps be said that those excesses, if occasioned by the moisture of the air, imply neither fraud nor evasion: it will be recollected, however, that any increase in or excess of weight, occasioned by moisture, if it escape the officer, goes into consumption without payment of duty; and that to the extent of the increase, whether made by accident or design, the proprietor of the salt, besides the prime value of the article, has the advantage of the duty. With respect to bonds entered into for salt exported, or to be employed in the fisheries, the Commissioners of Excise have a discretionary power to forbear putting them in suit, on such terms and conditions as they may think proper; and though it does not appear that the Commissioners have by law any express authority to discharge bonds that become forfeited, yet they have always exercised that power in cases where no fraud or design, or wilful negligence, could be imputed; of which many instances have occurred in regard to bonds given under the salt-laws, where the return of certificates has been delayed beyond the time limited by law for the production thereof.

It has been said, and probably with truth, that the time given for the production of certificates of the delivery of salt is not in every case sufficient, and that the sureties in such cases become liable to the penalty of their bonds, where no irregularity is committed, and where a compliance with the law is impossible. This danger, like many others, is in a great measure obviated by the discretion which the Commissioners always exercise; but if it were deemed necessary, the law might in this respect be altered, though

perhaps it would be difficult to make such provisions as should meet every possible case. It is certain that the Board of Excise have not in a single instance directed a bond to be put in suit. There are, however, very many bonds outstanding, some of which the Commissioners have not thought themselves warranted to discharge; and in representation to the Lords Commissioners of his Majesty's Treasury, the Commissioners proposed, "with their Lordships' concurrence, to accept of bonds to the amount of the single duty; and they suggested the expediency of forbearing to put bonds in suit, unless in case of strong suspicion, or direct evidence of fraud." They at the same time submitted in all cases of deficiencies exceeding the proportion of one *per cent.* upon the quantity of salt shipped (unless where relief could be legally obtained), that the securities should be called upon for payment of the single duty, and that such payment should in no instance be dispensed with.

There is reason to believe that the proposed relaxation of the law did not entirely remove the apprehensions and uneasiness of some of the trade. But considering that salt, if in any degree dried, will from natural causes alone absolutely increase in weight; that it has notwithstanding been proposed to allow for deficiencies to the extent of one *per cent.* and to accept security to the amount of the single duty only, it should seem that there could be very little real ground of alarm. It cannot be denied, however, that salt, with the duty upon it, as an article of very considerable value, that it may be clandestinely conveyed away with ease and facility, and that purchasers are every where ready and at hand; circumstances which, taken together, furnish almost irresistible temptation to plunder and embezzlement; and it is but justice to suppose that many of the deficiencies hitherto discovered have been occasioned by the depredations of the men employed on-board the vessels in which salt has been removed.

This

This inconvenience is not peculiar to the case of salt; it is, however, an inconvenience which it would be difficult to obviate; and unless by the means of security the proprietor of duty-free salt be compelled to exert and interest himself in the prevention of fraud and plunder, thefts will be committed and connived at.

It is admitted that the salt will increase or decrease in weight by being exposed to the air; and there is no provision in the law to allow for excesses or deficiencies. But with regard to salt captured by an enemy, or lost or destroyed through stress of weather, or storms at sea, or by the casting away, sinking, or stranding of any flat, boat, barge, or vessel, in which the same may be removing, provision is made for re-payment of the duty, or cancelling the bond, as the case may require. This provision is nearly similar to these by which the like allowances for loss or waste were obtained under the old salt-laws.

Complaint has, nevertheless, been made of the delay and inconvenience occasioned by an appeal to the Quarter Sessions, and it has been proposed not only to extend the power of granting relief to all cases, even of partial loss by accident at sea, but to vest the power in a principal officer of Excise, upon oath of the fact made before such officer. Upon this proposal the Commissioners of Excise, in a report to the Lords of the Treasury, observed, "that they could not but prefer a solemn investigation, as at present conducted, to the mode proposed; especially where duty to so large an amount is depending, and where (not to say any thing of the inefficiency of oaths in such cases) both the proprietor of the salt and the officer of the revenue would be exposed to almost irresistible temptation. Indeed, the temptation under such circumstances to venture at fraud, in the hope of purchasing the connivance of the officer, must be very obvious: it is certain, that no expence and very little delay ever occurs in applications for relief to the Commissioners

missioners of Excise, who have a concurrent jurisdiction in such cases with the Justices in Sessions. But it may be presumed that delay will often be occasioned, and expence incurred, in applying to the Quarter Sessions. This is certainly an inconvenience; but, like most of the other inconveniences in the case of salt, it is not peculiar to the laws under which the duty is at this time collected; and it is hoped it will not be deemed impertinent to remark, that the provisions of the old salt-laws, especially those under which bonds were taken and permits required, do not materially differ from the existing laws.

The Fisheries

are encouraged and promoted by bounties, and the use of the salt duty free; but to prevent abuses the legislature has established a variety of provisions. Salt intended for curing and preserving fish is removed under the security of bonds, and accompanied by permits; the effect of which, as interrupting or obstructing the trade, have been already described.

Fish-curers, before they can receive the salt duty-free, must make an entry with the Excise, and (except where the Lords of the Treasury shall interpose by their warrant) must provide cellars, or warehouses, for storing the salt. They must give bond to account annually with the Excise for all salt received, and not to misapply any part of it. They must also verify their annual accounts on oath, and produce to the Excise officer all fish for which they mean to take credit; and they are required in some cases to mark the fish in the presence of the officers, and in others to brand the casks in which they are packed. These regulations are essential to the safety of the revenue, but they are at the same time troublesome and expensive to the fish-curer.

The quantity of salt allowed for the curing of fish is in some cases too small; that inconvenience, however, might be remedied by an alteration of the law. Whether the salt-laws have obstructed the fisheries, or prevented persons from engaging

engaging in them, it is, perhaps, difficult to ascertain: it is, however, very evident that while a high duty is to be collected on salt, the laws which relate to the use of that article duty-free cannot be materially altered, or safely relaxed. At the same time it must be admitted, that those laws neither are, nor can possibly be rendered entirely effectual to the prevention of fraud. In one part of the kingdom it has been found extremely difficult to apply the laws to the mode of using salt in the cure of fish.

For preserving pilchards the salt is repeatedly applied, until it becomes so foul and blended with extraneous matter, as to be fit only for manure; and after it has been once used and is mixed with fish-scales and other substances, it is impossible to distinguish the salt, to ascertain the quantity, or to form any check upon the application or expenditure.

In the Session of Parliament of 1801 a temporary Act passed, which has been since continued, for allowing salt duty-free for the cure of fish for home consumption, either in bulk or in barrels; and it is asserted that considerable quantities of fish have in consequence thereof been preserved and brought to market in a good state, which would otherwise have been destroyed. This Act has not been so extensively beneficial as it perhaps might be rendered by an alteration proposed; but by that alteration the revenue would be more exposed to fraud. The regulations of this Act have not, it is believed, been complained of, but they are by no means calculated to secure the revenue effectually.

Conclusion.

The predominant inconveniencies with which the execution of salt-laws are attended, have been stated. Some few of the subordinate regulations of the Act of 1798, which relate to the manufacture of salt, might perhaps be repealed without material risk to the revenue; and these regulations, though not in general complained of, are certainly not altogether

gether free from objection. Many of the advantages which would result from a repeal of the duties on salt, and of the laws by which those duties are secured and collected, must be obvious. And, except as to the revenue, or finding a direct substitute for the duty (upon which no opinion is given) it is presumed that no inconvenience could arise from such repeal, for which the wisdom of the Legislature would not be able to provide an adequate remedy. It is nevertheless suggested, though with the greatest deference, whether an unqualified repeal of the salt-laws might not in its effects be injurious to the trade of England, and to the proprietors of certain salt-works both in England and Scotland.

It has been frequently said, and it is presumed the assertion is founded in experience, that if English refined salt could be obtained in Scotland, at the same or even at a somewhat higher price than is paid for the marine-salt procured and sold in that part of the kingdom, the former would be so generally preferred, as to occasion the ruin of the salt-works here.

Whether the works in Scotland might not in general be continued, and even benefited, if the unrestrained use of English rock-salt were permitted, is a question the writer is not able to answer; but it is recalled to the recollection of the Committee, that under the salt-laws the use of rock-salt is restricted to refineries within the distance of ten miles of the salt-pits, and to such other established refineries as were set up previous to the passing of the Act in 1798; and the salt-works in England which are allowed the benefit of rock-salt, do not exceed one sixth of the whole number. If then the use of rock-salt were universally allowed, it is humbly submitted whether the proprietors of those refineries who now enjoy an exclusive privilege, and those who have the advantage of a very strong brine, and who, under the sanction of the laws, may be supposed to have erected or extended their works, might not be materially injured.

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REPERTORY

OF

ARTS, MANUFACTURES,

AND

AGRICULTURE.

No. LXXI. SECOND SERIES. April 1808.

Specification of the Patent granted to WILLIS EARLE, *of Liverpool, Merchant; for certain Improvements in the Tillage and Dressing of Land, and the Cultivation of Plants.* Dated January 13, 1808.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Willis Earle do hereby declare, that my said invention of "certain improvements in the tillage and dressing of land and the cultivation of plants" is described and ascertained in the following manner; that is to say: the improvements principally consist—

First. In so managing the land in tillage, that, in many cases, after producing a crop, it is or may be worked with great expedition, and sufficiently to be capable of receiving another crop, by means only of such plough or ploughs, as, however otherwise constructed, have respectively two mould-boards, and throw the earth raised by them to each side of their furrow; or otherwise

by means of such plough or ploughs, assisted by one or more harrows and a roller, or either of them; or by means of other instruments having similar effects: such culture being attended with many important and peculiar advantages, especially in the disposition and cropping of the land, and being also, in great part, applicable after a course of ordinary tillage.

Secondly. In an expeditious, and ultimately economical, method of manuring or dressing land, peculiarly adapted to the before-mentioned system of cultivation; whereby the manure or dressing is more suitably distributed, and rendered more effective than by the usual processes.

Thirdly. In certain convenient modes of combining and conveying manures or dressings to be laid on land, or incorporated with the soil thereof; and in the extension and improvement of various methods of cultivation already in practice.

Fourthly. In the combination of any of the before-mentioned improvements in the culture of the same piece of land.

The operations are performed as follows; *viz.* The first, by drawing parallel furrows with a plough having two mould-boards longitudinally along the ridges or flat ground, as the case may be, at such distances from each other that one part of the soil shall be completely stirred to a proper depth, and the whole, or nearly the whole, surface of the remainder covered with such part thereof as is thrown out of the furrows to each side by the respective mould-boards; if the land has been kept tolerably clean during its occupation by the preceding crop, and if the ploughing be performed so soon as that crop is removed, all small weeds will thereby be buried, and

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in many cases, the new crop may immediately be sown, either by a drill or otherwise, in the furrows just made. If a loose soil be wanted in the furrows, or they be thought too deep for the intended crop, a suitable harrow may be worked over or within them previously to the sowing; in either of which cases they will be partially filled again with soil; and in the former many of the weeds on that part of the surface which was not broken by the plough will be torn up, whereas in the latter they will remain buried. But a good general harrowing will be necessary on account of the weeds, whenever they cannot be sufficiently covered by the ploughing; and a succession of ploughings and harrowings may sometimes be desirable. If the land has borne corn, or any similar crop, and if it is in a dry state at the time such crop is removed, it may be eligible to use a roller before the plough, in order to bruise and break down the stubble, and also for other purposes; and harrows may often be used with considerable advantage, for tearing up weeds and loosening the surface, before the plough is employed.

The preceding crop on this land may be supposed to have been put in, either on the drill or broadcast system; if it has been drilled, and in single rows, at any distance from about fifteen to thirty inches asunder, it will be in a state well suited to the proposed operations; there can be no difficulty in drawing proper furrows for the ensuing crop by stirring each interval with the plough; and very little practice will enable the ploughman to draw straight and parallel furrows with that instrument on ground which has been sown broadcast. These furrows once made, it will be at the cultivator's option whether immediately to put the seed into them, or previously to

employ a harrow of any kind; and then, whether to re-open the furrows before sowing, or to sow upon them when more or less filled up again by the harrowing. He will then have to choose his mode of covering the seed sown; and it is recommended, that, when practicable, he should harrow or rake it in within the furrow, as hereinafter described; the seed may however be harrowed or raked in after any other manner; or it may be covered by ploughing upon it the soil of the yet unploughed ground, this operation being followed, or not, by another harrowing. Even for this last described ploughing, the plough with two mould-boards is most suitable, throughout, on ground laid flat; and also for ridged land, in ploughing all the unbroken spaces, except the outside ones of each ridge, for which a plough with a mould-board only on one side is undoubtedly preferable.

Hand-hoeing or horse-hoeing the crop when in growth, or other similar culture, will often be requisite, both for keeping the land clean, and, in some cases when the second improvement is adopted, for carrying the same into effect. It may of course be done to or from the rows, according to circumstances; but to give perfection to the system here proposed, it should be performed with great care, so that not a weed remain, at least to ripen its seed.

In corn crops, rows from about eighteen inches to two feet asunder are recommended, as the interspaces between rows at such distances are most convenient for the greater part of the operations; and because, if the land be in good heart and the seed sown early, they are quite near enough to afford a full crop. It is to be remarked, that every alternate year there will, in ridged land, be one row less to each ridge; unless it be found worth while

while to sow the interfurrows between the ridges, or to add a row to each ridge, every such alternate year.

In making the furrows as first described, it will in general be proper, especially when the intervals in which they are to be made are wide, to use a plough of the expanding kind, and having a share extending on each side beneath the soil not displaced by its mould-boards; or at least a plough with such share; so that not only a sufficient furrow may be provided for the seed; but also, that the whole, or nearly the whole, of the ground may be more or less disturbed. It is enough for the crop while young, that the centre of the interval be turned over and well loosened; the after-culture will loosen and supply more soil when wanted; but in order that its operations may be easy and effectual, and also for other reasons, it is desirable that the plough should stir, in a certain degree, the whole land, or very nearly the whole of it, before the crop is put in. If any difficulty attend the ploughing wide intervals or deep soils with this intention, it will readily be overcome, in most cases, by two operations; either of a smaller and then a larger plough, or of the expanding plough, first closed, and then somewhat expanded; that is, in the case of wide intervals: and in that of deep soils, by a process of the opposite nature. Successive ploughings of equal extent, but at different depths, may also be employed for the same purposes.

In the practice of this system of cultivation, the agriculturist will of course take care not to misapply it, by attempting land too foul with weeds, or too stubborn from the tenacity of its nature; nor in any case by the number and complexity of operations to defeat one of its principal objects—the saving of time and expense. In

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almost any instance where it may be immediately applicable, two ploughings will be found to suffice; but in every case it must previously be considered, whether any combination of the described processes will be preferable to a complete working of the land according to the common methods: or whether such working of it ought not to precede and be made subservient to this species of culture.

When land is in a very clean state, not stony, and the soil of a loose and friable nature, the following combination will often be found of easy practice, and is evidently attended with great advantages; this is, to perform the ploughing, the sowing, and the covering the seed all at the same time; leaving also the soil thrown out by the mould-boards of the plough, or the greater part of it, ridged up on the intervals between the new seed-furrows. To effect these purposes, it is only necessary to use a plough, suitably fitted up with a drill immediately following it; and that there be attached to the drill a small harrow or rake, made sharp-edged, and a little wider than the bottom of the furrow; or in any other manner, so that it may be capable of working easily within the furrow, and of thereby drawing from the bottom or sides of it only a sufficiency of earth to cover the seed. So much expedition however may sometimes be unimportant; and if this compound operation appear difficult, or hazardous, on unstirred ground, it will be found both practicable and safe, after the furrows have been once opened by a plough without a drill; or the drill and rake, or harrow, may be used alone after one such ploughing.

The above, or some equivalent mode of covering the seed, is recommended in every case to which it can be applied;

applied; because it is, in many respects, of the greatest advantage to have the soil ridged up on each side of the rows of young plants, until such soil be wanted for their support and nourishment.

The rake or harrow which works within the furrow may in any case be attached to a plough instead of a drill, before cropping the land, or used alone, either before or after cropping, as may be found convenient.

When the new crop is to be a transplanted one, furrows may be opened with the plough, and a loose soil within them prepared for the young plants, in any of the modes before described.

It must be obvious, that the practices which have been here suggested, with respect to land which has remained in the state wherein it was left by the preceding crop, are, in many instances, equally applicable and well suited to land broken up and brought into proper tilth and form by any of the usual methods.

The second operation is performed as follows; *viz.*— In land cultivated as before described, by covering the seed when sown in such a manner, whether as before-mentioned or otherwise, that the whole or part of the soil, which the plough had thrown to each side of the seed furrows, is left ridged up, at least sufficiently to form such furrows into so many channels fit for the conveyance of water or other liquids: or, in such or any other land which will admit of such process, by forming, as before-mentioned, or by means of one or more hand or horse hoeings, or each of them, or in any other manner, either the seed-furrows, or the interspaces between them, or both, or any part of the ground, as may be deemed most adviseable, into such channels. And then by conveying any liquid, or any required species of manure,

nure, compost, or other substance, capable of being mixed with and suspended in water, or other liquid, so mixed and suspended (in whatsoever mode or modes such mixture, suspension, and conveyance may be accomplished) into such channels, at such seasons, whether before putting the crop into the ground, or afterwards, or both, and in such proportions, as may be thought most eligible. It is of course supposed, that the land be regularly laid down, whether on a flat, or a slope, or variously; that, where it is not on a perfect level, the higher parts first receive the liquid, and that there be proper drains and water-furrows to carry off any superfluous moisture which by stagnation might be injurious. And the admittance of the mixed water, or other liquid, into the channels, ought to be so far gradual, and so regulated, that, as nearly as possible, the whole may be absorbed by the soil in its progress along the channels; whereby the manures or other substances therein contained, will partly incorporate themselves with the soil, and partly be deposited thereon; and in that precise situation where they will have, or be made to have, the most beneficial influence upon the plants growing, or to grow, in or between such channels. The superfluous moisture itself will filtrate through the soil, and pass off in like manner as rain into the water-furrows.

In almost every instance this will be found the most eligible process; but when the liquid is abundant, and other circumstances are favourable, it may sometimes be advantageous to cover the land by a more general overflow.

The third operation consists in, by any means whatever, disposing the substances wherewith land is to be dressed, into a compost, or otherwise, so that they will be

be either soluble in water or other liquid, or so far light and friable, that, when agitated in a running stream of water or other liquid, they will partly, or altogether, remain therein suspended, at least long enough to admit of their being carried by its force into such channels as are before-mentioned. And, after putting any substance or substances of this description into water or other liquid, and agitating them therein, and mixing them therewith, by any means, whether natural or artificial, in conducting the water or other liquid, so mixed and impregnated, by suitable methods, into such channels. But more particularly in the following mode of executing the last-mentioned processes; to effect which it is desirable that the land intended to be dressed should be situated several feet below the level of whatever liquid is to flow over it. A pit is then to be made, communicating at pleasure through proper channels, and by means of valves, sluices, or other contrivances, with the liquid on the one hand, and with the land that is to be floated on the other; upon a level with the highest part of such land, and at or near the bottom, or lower part of the sides, of this pit, should be the apertures of both its communications. These arrangements being made, the sluices closed, and the pit empty, or nearly so, some of the manure or dressing substance is thrown into it; the sluice for admitting the liquid is then opened, when such liquid, according to the pressure of its column, will rush with violence into the pit, and amongst any substances therein contained, by its own force alone considerably agitating them, and mixing itself with them; to which, as may be convenient, or appear necessary, any other means of agitation may be added. As the liquid flows into the pit, more of the dressing substances are from time to time thrown in likewise. When the

liquid is deemed to be sufficiently impregnated, the other sluice is opened which permits it to flow upon the land. The first sluice may either be shut at the time the second sluice is opened, and only one pitful of impregnated liquid may be used at once; or the pit may be continually supplied with the aforesaid substances, and the liquid continually admitted and let out; but in the latter mode, care must be taken not to suffer the liquid in the pit to rise too high, or the entering liquid, from the resistance it meets with, will flow in but weakly, and of course contribute little towards its mixture with those substances. In either mode, the liquid will move towards the land with a rapidity proportioned to its elevation in the pit above its surface in the channel of communication, such channel being formed on a perfect level.

A pit of this kind will also be useful for the more convenient and perfect impregnation of limited quantities of water, or other liquid, although the body or stream from whence it is supplied be nearly on a level with the land to be floated. But in such case the mechanical impregnation must always be more laborious and expensive than when the liquid comes from a higher level. In many cases it may be desirable, some time before the land is to be dressed, to put into the pit a quantity of the dressing substances, admitting some liquid, in order, to a certain extent, to facilitate the impregnation, so far as it may depend on chemical agencies, or on the solution or softening of the materials.

One or more gratings will be necessary in the pit and channel of communication, to prevent any accumulation of substances which might obstruct the passage of the liquid to the land; and the clearing of such gratings will frequently require attention.

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These methods of dressing land are of great importance, both from their intrinsic nature, and from the choice of time or times of using them afforded in situations where water is at command; for this enables the farmer to manure his crops according to any exigency, and at whatever period of their growth. Nor are the benefits of this third improvement by any means restricted to such land as is disposed in rows or channels; they are applicable, although almost always in a less degree of utility, to any other lands, whether arable or not, which are laid down in such a manner that a stream of water may be made to flow over them.

And where water cannot be procured with certainty, or at the most eligible season, it will be of great advantage to convey any compost or other dressing substance in carts or otherwise, and to deposit the same, in any suitable manner, upon land intended to be cultivated in rows or channels, either previously or subsequently to the use of a plough with two mould-boards as before directed; the operations of which and of the harrows, or of either of them, will mix it intimately with the soil. If water is afterwards obtainable, it may be employed, either alone or as before-mentioned. In some cases too, it may be adviseable purposely to adopt this method and order, although water be always at command; in others, to use water only; and in others again, to omit entirely the use of water.

Be the crop, or the land, or its disposition, however, what they may, the use of water, at some period, can scarcely fail to be of service, although it may contain no artificial admixture; and although no manure or dressing may have been given to the land.

The common watering of grass land will also, in some cases, be greatly improved by the disposition of the land as before-mentioned, or otherwise, into rows and channels. And channels may easily be formed in various ways, on any ground already laid down for irrigation, or regularly flat, or in an inclined plane, or even in ridges, if regular: it is sufficient to cut out narrow sods longitudinally along such ridges, or other land, at proper intervals, by means of a suitable plough, or other instrument: the sods will be valuable in compost. The water will much more easily be made to flow along the channels left by them, than over the surface of the ground, however even; but in most cases it may do both; and in these modes of application it will be found at least equally beneficial to the grass plants, which will grow with more vigour than before, from the liberty given to their roots. As the channels fill or grow up again, which they generally will in a short time, some ploughing or hoeing instrument should be employed, and this may be formed so as to open two or more of them at once. After the soil or sods thrown out have been removed, a roller or bush-harrow will be useful.

Fourthly. The before-described improvements, and the several processes of which they may consist, are evidently susceptible of many different combinations. The comparative propriety of these can only be determined by the circumstances of each individual case; nor would it be necessary to afford any particular example. The following combination, however, which comprehends the more important parts of each improvement, is stated, somewhat in detail, for the better elucidation of the general system:—

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The ground in culture may be supposed to have borne a crop of wheat drilled in rows at the distance of twenty-one inches, and to be left thereby in a very clean state. The crop being taken off by the end of August, the ground is rolled, and then harrowed; an expanding plough of the description before-mentioned, and displacing about eight or nine inches of soil in width, then opens a furrow in each interval. These operations are supposed to be performed as soon as possible after removal of the crop, and a large portion of ground may be so worked by the middle of September. The new intervals, with the stubble and any weeds which may be upon them, are covered with the soil, ridged up on each side of the furrows; and the original soil of those intervals, or the greater part of it, is gently moved by the lateral parts of the ploughshare. About the middle of September (of course beginning with the land first stirred) the plough is again passed through the furrows, having attached to it a rake or harrow which works within them, and loosens a portion of soil. Respecting the depth and width of the furrows, absolute or relative, in each ploughing, circumstances must determine. A new crop of wheat is then sown, a single row in each furrow, by means of a barrow-drill, which has likewise attached to it a small harrow or rake of similar nature; this completes the cropping, and leaves most of the soil which had been thrown out of the furrows still ridged up. After the corn appears it will be proper, as usual in accurate cultivation, to examine the rows, and supply any vacancies, by fresh seed or by plants; but in performing this work, the husbandman ought not to walk on the small ridges, but in the furrows; from which, in dry weather, the plants will receive no injury. Before the wet season comes

comes on, a slight hand-hoeing, or raking, and chiefly upon the sides of the small ridges, (the operator walking backwards in the furrows,) will generally be desirable; and if the land has been every where properly water-furrowed or drained, no farther labour is likely to be requisite through the winter. Early in spring a second examination of the rows should take place, in some tolerably dry weather, and any vacancies should be planted up; the husbandman again walking in the furrows, from which he must remove all obstructions, and the sides of which he must ridge up anew, if either be any where necessary; he must, in short, supply whatever is wanting to form the furrows into good water-channels. At or about the same time, the earth round the plants may be stirred, and the weeds, if any, may be destroyed, in whatever may appear to be the most proper mode. After this, the plants being supposed to be already strong, some opportunity of dry, generally, rather than moist weather, is embraced, for conveying any required manure or dressing, by a liquid medium into the furrows and among the plants in them, according to some of the modes prescribed by the second and third improvements for land disposed in rows and channels. When this operation has been well performed, it cannot often require repetition, and the crop will afterwards employ no very large portion of the husbandman's time until harvest; since two hand-hoeings, or rakings of a very easy nature, will generally suffice: the first, as weeds begin to appear, will bring down the tops of the small ridges into the furrows;—and now the operator should walk forward upon those ridges which he reduces by his instrument. The second, and if wanted a subsequent hoeing or other such-like process, will destroy all succeeding weeds, fill

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the furrows, and earth up the plants. Should a second manuring or watering be desired, or a single one be preferred after the plants are earthed up and well grown, it is easily, but not quite so well, performed by hoeing the intervals into the form of channels; at least it must be obvious, that these can never be so large and convenient as the original furrows, the space occupied by the plants being in a great measure substracted.

Many other combinations of the improvements, some more, some less connected than the above with ordinary operations of husbandry, might be suggested; this is only offered as generally an eligible one: and the successive adoption of it, for a course of years, would in each afford every reasonable prospect of an abundant crop. Yet the expense and labour of this culture, especially if water properly situated were at command, would even be less than that of any other now in practice, where land is kept really clean, and constantly in tillage. There are only two ploughings; and these, both together, not equal, in general, to one common ploughing. One rolling, one harrowing; from three to five hand-hoeings, or rakings, or other equivalent operations, but all of the easiest nature possible. The sowing by a drill-harrow is indeed slower than by a large drill, but it is more secure: the operations of the small harrows or rakes within the furrow add comparatively nothing to the amount of the labour. In regard to manure, there is a great saving: it is applied immediately to the plants, and scarcely any part of it can be lost in evaporation, or in the nourishment of weeds; a very small quantity therefore will suffice. The economy in its amount will, in a very few years, counterbalance any expense that may attend the making of the pits, sluices, &c. As to the

the expense of mixing and conveying the manure, it will probably in no case equal that of any common process; that is to say, for manuring an equal quantity of land in an equally sufficient manner.

With regard to any description of draining, the expense and labour of it need be no more than in any common case, where it is well performed; but it must be performed effectually, and in a very accurate manner; because the plants, from their situation under this management, would otherwise be frequently more liable to injury from superabundant moisture. For the same reason it will be proper, in all cases where land requires to be laid down in ridges, to take especial care that the ridges be sufficiently high and round when first set out; more particularly, as under this system they are to last for more than one season, and as they will have a tendency to become flatter every year, in consequence of the operations to which they are subjected. Whenever there is hazard of their becoming too flat, they must be wholly ploughed up and formed anew; of course in such mode as may appear most eligible.

Horse-hoeing growing crops under this culture can only be proper where the intervals between the rows are of a suitable width. But the plants, having soil ridged up on each side of them, would seldom require it.

The use of any instruments or modes of cultivation here pointed out, is not understood as precluding that of any other modes or instruments which may be deemed proper, in any circumstances; but for the working of land in certain cases, the first improvement renders unnecessary the employment of any other instruments than such as are thereby designated, so long as the ground is in a state of preparation for a new crop. The

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referred to, are or may be such as are commonly used for the mere purpose of horse-hoeing a growing crop.

It is also to be understood, that this invention does not prescribe any invariable order in the succession of operations.

Although the system here developed be peculiarly adapted to the culture of corn, it is suited to that of a great variety of other plants, both of the annual and of the more durable kinds, and whether sown or transplanted.

The patent right of this invention is to be considered as extending to its application, either in the whole, or in part, in every instance whatever, whether it be used alone or in connexion with other operations; and although other instruments, or other methods, than are here mentioned, may be employed to accomplish all or any part of its several improvements.

In witness whereof, &c.

Observations by the Patentee.

The leading features of this invention are—An expeditious and economical mode of tillage.—A consequent disposition of the soil into alternate small ridges and channels, by a peculiar management, preserved through various operations; which, at once, facilitates the cropping, prepares for subsequent improvements, and, whilst it affords protection to the infant plants, secures the benefit of an advantageous fallow.

The manuring or dressing land and plants by the medium of liquids introduced into such, or other suitable channels.

The combination with liquids, and conveyance into such channels, or otherwise, of the substances wherewith land is intended to be dressed.

turned over to any considerable depth without the destruction of the plants, nor, situated as they are upon its surface, can much of it be drawn to their roots. Indeed when plants grow upon the highest part of the surface of land, it is impossible to draw any considerable portion of soil to their roots, unless the intervals be very wide. Any hoeing therefore of these small intervals does little more than loosen the soil, and destroy weeds; its other important office of earthing up must be left almost wholly unperformed; and this being the case, an extraordinary supply of manure would, in very few instances, be found a remedy; for the plants, from the first, would be large and vigorous in proportion to the richness of the soil, and therefore would only the more stand in need of food, and air, and support, as they increased in bulk; they might indeed obtain a greater supply of nourishment than smaller plants by throwing out stronger and deeper roots; and these might also give them a somewhat firmer hold of the ground; but, generally speaking, in so confined a situation, some requisite would fail them at a critical period; and they would run entirely to straw, or be lodged by the rain and winds. So decidedly has this truth been ascertained by repeated experience, that farmers are particularly, and very justly, careful to avoid putting their grain, and especially their best kinds of wheat, into a rank soil. The consequence is, that the plants are generally of a small size, with few stems, and short, or scanty ears, of which also nearly half the bloom is frequently imperfect, and of course unproductive. They scarcely appear to be of the same species with some insulated plants occasionally found in favourable situations.

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The proper corrective of these inconveniencies will be apparent on a due consideration of the nature of the growth of corn plants. It is observable that their crowns, from whence both the stems and the main roots proceed, are formed on the surface of the ground, or at a very small distance therefrom; one or two inches perhaps at the utmost: at whatever lower depth the seed may be placed this position of the crown is invariable. But although, in the infancy of the plant, its crown will not endure a load of soil, it derives much benefit from, and for its perfection even requires, a pretty considerable one at a more advanced period. Hence it appears, that effectual provision for the prosperity of the plant cannot be made by the mere deposition of the seed at any particular depth: and that some arrangement, suited to the various stages of its growth, can alone attain this object. If then the soil be disposed so as never to encumber the plants with an unnecessary load, and yet be always applicable to them, in the requisite proportion, with the least possible labour, the greater part of these inconveniencies will be sufficiently obviated.

Another observation however occurs; although on the one hand the plants must have a sufficiency of room for their healthy and vigorous growth, there ought on the other, if possible, to be no useless vacancy. Almost all the expenses attendant upon agriculture are, more or less, in proportion to the extent of the land cultivated; and it may be assumed generally, that the smaller the quantity of land employed, in the creation of any given quantity of produce, the greater will be the profit. Indeed it is only when the manure and labour expended on the smaller portion of land exceed the amount of manure and labour bestowed on the larger, the produce

in both cases being equal, that any comparison between them could be instituted; for in the former there would always be a decided advantage in the articles of rent and seed.

On these grounds the system before described is confidently offered to the consideration of agriculturists. It will certainly be found capable of drawing from any given piece of land (for which it is not essentially unsuitable) a greater produce, at least of grain, than can be obtained by any other now in practice: in the aggregate too, not merely without any greater, but even with less expense than is usually attendant upon the most approved modern husbandry. It is peculiarly calculated to remedy the defects in cultivation which have been just pointed out. The land may with perfect safety be manured to any desirable extent: it is only necessary to allow intervals between the rows of plants proportionate to the size which it is expected, and wished, that those plants may attain; no other consideration ought to operate in determining the width of them; if each interval contain a ridge of soil, which, when gradually brought down to the roots and stems of the plants, is sufficient to support them against the effects of rain and wind, and be also wide enough to admit a proper circulation of air, such interval will be perfectly adequate to every other occasion; for no hoeing, which can be expedient, will ever require an additional width. Indeed the space between the rows, necessary for giving air and headroom to strong corn plants, is not inconsiderable; the leaves, when in full vigour, cover very thickly, much more ground than is occupied by the roots; and hence it follows that the *maximum* of a corn crop, which might be raised on a given quantity of land, is not the utmost

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which the soil might nourish, but the utmost which on a surface of such extent can be properly ventilated. Crops are frequently lodged in particular rank spots of ground; and this circumstance will almost always be found to have arisen from the want of air among the plants, which rendered many of the stems weak and top-heavy; whilst the soil remains yet rich, so as even to demonstrate its rankness in a succeeding season.

It is here proper to remark, that row-culture of every kind is the most favourable to the due ventilation of growing crops; and, with regard to the peculiar row-culture here recommended, that the soil, being ridged up between the rows of plants, is not only the most conveniently disposed for successive application to their roots, but is thereby calculated to give them the firmest support, and also with the least possible occupation of space; for by no other means can an equal number of plants, on equal space, receive fresh supplies of soil to so great an extent.

Respecting the combination of manure with liquids, and its application to land in that state, there seems to be no necessity for adding much to what has been already detailed in the specification. These improvements are certainly considered by the inventor as conducive to the production of better crops than could be obtained by any other mode of dressing; but, wherever water can be freely commanded, he chiefly wishes to recommend them on the score of economy; and he is even of opinion that the expense of collecting small runs of water, and making reservoirs for its reception, (which he has himself done on a farm of little more than forty statute acres,) will often be well repaid by the benefits of their practice. However, he is far from asserting that, if land

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be adequately manured in any other convenient manner, great and successive crops will not be derived from it by means only of the peculiar tillage and management suggested under his first head of improvements; and it is certainly probable that agriculturists will be more readily disposed to make experiment of these than of the other. But he is not anxious in the present instance to invite trials of any kind; unless indeed the person who may feel an inclination to make them be intimately convinced of the correctness of his reasoning, and firmly resolved to do justice to the experiment. In the course of another year he hopes to be able to support his system by facts more decisive than any which, as yet, it is in his power to mention; and at all events, if health permit, he will then communicate to the public the result of his farther experience.

Should any one, however, be disposed to put in practice the rules of the first improvement, it is recommended to him, if the land intended to be so treated is not already in high condition, to dress it previously with some good friable compost; and this in preference to any manure in a less manageable form; because the application of it will more easily accord with the simple tillage that is to follow.

In the study and prosecution of these improvements, public utility, as well as private advantage, has been with the inventor an important object and animating principle. And he has the consolation to reflect, that, to whatever extent his system may succeed, it will throughout be attended with beneficial consequences. Although it purposes to increase the amount of produce, and, on the whole, to diminish that of labour and expense, it can never give encouragement or reward to idleness:

idleness: the husbandman must have diligence, care, and attention, or his crops will be inferior to those raised in the common methods; but possessed of these qualities, and having once got his ground in order, he will never afterwards be liable to the same anxieties; he will not be so much hurried in his operations, nor ever in danger of a late seed time; provided only that he be alert, and do not imprudently attempt too much. For though in most parts of this island, it be preferable to sow drilled wheat in September, it is not necessary; and an increase of seed will obviate the chief inconveniences of a later sowing through great part of October. He will, if he think proper, be soon enabled to diminish considerably the number of his working cattle; though, on the other hand, his expenses in manual labour will, in such case, be somewhat increased; but by no means in equal proportion if the quantity of his arable land continue the same as before. This effect, of a change in the species of labour requisite in agriculture, is a circumstance at all times of the highest importance in a national view, and, in the present situation of the country, particularly interesting: its value too is enhanced in no small degree by the consideration, that the increased demand for manual labour would manifest itself at seasons of comparative leisure, and in calling forth the exertions of those who are least employed. For it would be caused only by an increase in the practice of hoeing and cleaning crops, operations which interfere little with any harvest, and which in great measure may be performed by women and children.

These considerations lead naturally to another, which, in various parts of the country, may prove to be important, viz. that agricultural labourers, occupying a few

acres of good, and not stiff land, may from this system derive a greater facility in its cultivation. They would have no occasion to hire a plough-team annually; their land being once properly worked, and laid down, whether flat or in ridges, their own labour, joined to that of their children, would perfectly suffice for its culture during a course of years; with the sole addition of some little assistance from a hired dung-cart. All the preparatory tillage necessary for their crops might be performed by an expanding hoe worked by themselves, twice, or oftener, in each furrow; the price of an instrument of this kind, as made by Mr. M'Dougale, No. 422, Oxford-street, London, is two guineas. If grain were their crop, the sowing might be performed by hand, or with a drill-barrow; cost, as above, two guineas and a half. But if, as is probable, these, and the few other requisite tools, were too heavy an expense for a single labourer, several might combine to purchase them in common.

It may be supposed by many that a system of agriculture, professing to require much aid from manure, is little calculated for the benefit of labourers. But it has not here been admitted that manure is more requisite in the practice of this system, than in that of any other; according to none will the produce of the crops be very considerable, unless the land be in good condition; and to keep it so for any given number of crops, will certainly be possible at a less cost of manure, under the tillage here suggested, than under any other now in use; because it affords better opportunities for the subversion of exhausting weeds, and because the land is, for a long period, so disposed as to receive more benefit from atmospheric influences.

It

It is worthy of remark that the labourer, or small farmer, cultivating only a few acres, is frequently led by poverty to adopt a rule of conduct, which all farmers, from the highest to the lowest, would do wisely to observe on principle; this is not to attempt to raise a crop of corn, at least of wheat, on poor land. It would be greatly for their interest to crop no more land than they can manure sufficiently, bestowing all the labour they can spare on hoeing and cleaning it, and preserving the remainder of their farms in the state of grass, which, properly managed, is always a state of improvement.

Neither these observations, nor any of the preceding ones, are intended to inculcate the idea that farmers ought never to keep under the plough more land than they can maintain in high condition. Such a rule may be very proper in many instances, but is not applicable to general practice. Yet it is in the power of every farmer, and should be with him a maxim, to abstain from cropping all land which, if foul, he has not time to work sufficiently, or to which, if worn out, he can allot only an insignificant portion of manure: there certainly ought in all cropping to be a reasonable hope of profit. Accordingly when in any farm more ground is broken up than the occupier can sow with this prospect, it is better that a part should, in some mode, be fallowed, until it can properly be laid down to grass; and this part ought always to be, just as much as will leave him time and means to bestow on the remainder a workmanlike cultivation.

It is also a most important, but much neglected, principle of agriculture, that land, once in good heart and thoroughly clean, should carefully be preserved in that

condition; a moderate portion of manure and labour will then suffice for the purpose. But the present practice is very unfavourable to its accomplishment: all preparation of ground is slowly executed, and many weeds, remaining after harvest, have time to perfect and scatter their seeds before the plough can come to destroy them.

Although the author of these remarks, during the last two or three years, has made numerous experiments, on the result of which, joined to much observation and reflection, his system is founded; he has it not in his power to state facts, such as he might safely deem calculated to make upon the minds of others the same impression which has been produced on his own: the following, however, are of some interest, and he should consider himself blameable were he not to mention them.

In the autumn of 1806 he ploughed up some old grass land, which was well worked in the usual manner, laid in four-yard ridges, and sown with oats, broadcast, on the 9th April last; they were of the potatoe kind, and the proportion of seed *per* statute acre not more than three bushels, Liverpool measure. The land being rich, the crop from the first looked extremely well, and covered the ground as completely as could be wished, though not to the exclusion of weeds. Throughout a part of it, when a few inches high, lines were set along the ridges, so as to form six rows of plants, each nearly a foot wide, on each ridge; and whatever grew in the intervals between these rows was destroyed by the hoe; a full half of the plants, certainly, was sacrificed. Both this part of the crop, and what remained as originally sown, were carefully weeded; the earth in the intervals formed was drawn up, as much as possible, to the plants

on

on each side, and consequently left a small channel on each side of every row. When the plants stood about two feet high, some well-rotted stable manure, mixed with a little clay marl and lime, was floated into these channels, in the mode particularly described in the Specification. The proportion of this compost *per* statute acre was about five tons. The effect of these operations was soon visible in the comparative height of the two different parts of the crop; both, however, were very fine, and though, in consequence of rain, they both were lodged some weeks before harvest, they ripened pretty well on the ground. These oats were all cut the end of August. That part of the crop which was reduced to rows, was originally of the same aspect with what remained untouched, and the produce of four hundred square yards, very exactly measured, in each, was cut separately, and carefully laid apart for comparison; the broadcast, which had shorter straw, yielded fifty-six sheaves, producing when threshed seven bushels three pecks, Liverpool measure; the rowed part only fifty-three sheaves, but the grain was eight bushels complete; the weight of each bushel 43lb. The straw was not weighed. This produce, after the rate of ninety-six bushels and upwards *per* statute acre, though not unprecedented, is certainly uncommon, and will appear the more extraordinary when the late period of semination is taken into account; the rowed part of the crop was also cut rather too soon. Nor can there be any doubt that, if it had been originally drilled within a channel, and the adjacent soil afterwards drawn to its support, it would not have stood better, and also more effectually have ripened its produce. In what degree the soil of these

two

two parcels of ground may have been exhausted by their respective crops it is impossible to determine, at least at present; but the presumption is strong that the soil of the broadcast piece has suffered the most, making due allowance also for the small portion of manure expended on the other.

He has now growing (this 29th February) some wheat, sown in channels made by the hoe-plough, so late as the middle of November; part of which was covered merely by a slight hand-raking within those channels; the rest by a general harrowing in the common manner. The plants in both parts of the crop look well, nor is there between them, hitherto, any considerable difference; what difference at present exists is in favour of the former: yet the winter has been one of remarkable and various severity, and the soil, though on a slope, has a clay bottom. The channels too, having been made during the setting-in of frost, are but indifferently formed. The seed lies at the depth of about four or five inches below the *natural* surface of the ground; and the plants appear in the channels about as much below the tops of the small ridges. The advantage of having plants so placed in summer is such, that it would more than compensate for the loss of great part of their original number during the winter season.

The following experiments, though attended with results comparatively unfavourable, he also thinks important in the illustration of this subject.

In 1806 he sowed in channels, also raking in the seed within them, a small crop of Swedish Turnips, which *during the whole of summer* prospered exceedingly, although the land, ploughed up from grass, had no manure;

nure; but, trusting to the slope of the ground, he had not laid it in ridges, and towards winter the greater part of the crop was spoiled. The substratum of the soil was clay.

During the early part of last summer he subjected several small pieces of wheat to a treatment similar to that of the oats, before described; the results, so far as they apply, are perfectly satisfactory in establishing the principles for which he has contended. The plants tillered more, and grew very strong; the ears became large and fine, and ripened well; the wheat was never injured by the moisture, although one piece was actually under water for nearly three days; on the contrary this was one of the best pieces; and the intervals being wide, no part of it was ever lodged. All this wheat however, partly from necessity and partly for experiment, had been too thinly sown, the time of sowing considered, which was from the end of October to the 9th of December: the seed in no instance exceeded one bushel and an half *per* statute acre. The produce of course could not be expected to be very great; yet it was generally after the rate of thirty-two to thirty-five bushels *per* statute acre. It is proper to state that all the ground was in good heart, and that some of the wheat, left as originally sown, rendered a produce after the rate of forty-eight bushels *per* statute acre. All these little wheat crops therefore suffered in produce from the treatment given them, which indeed was merely experimental; the produce of some of them too is not fully ascertained, for, as they stood alone, it was much reduced by the depredations of birds. But if they had been sown in due season, or with a proper quantity of seed,

or

or even if the hoeing had been performed earlier, there can be no doubt that their success would have been very different. There was not leisure to perform the hoeing until the month of May, which left them no time to tiller sufficiently. Only two out of seven pieces of wheat treated, more or less, in this manner, had any part lodged; these were both raised from the same seed as a crop left as sown broadcast, and to which the same circumstance occurred; probably owing to the length of the straw. The weight *per* bushel alluded to was 65lbs. to 67lbs.

The terms upon which the inventor is willing to permit the use of his before-mentioned improvements are—for all or any of those described under the first article of the specification—two shillings and sixpence *per annum* for each statute acre; and an equal sum for the practice of the remainder, or of any other part, of his system—in all, therefore, five shillings *per annum* for each statute acre. But in the case of any land cultivated for themselves by labourers, usually working for hire, as far as the extent of three statute acres each, he does not intend to make any charge whatever. These regulations he at present apprehends he shall find no motive to depart from; but, as he cannot foresee what may happen to change his opinion, he begs to be clearly understood as not binding himself to them beyond the month of July 1809. In many instances this period may be considered as comprehending two seasons.

Specification

Specification of the Patent granted to JOHN WILLIAMS, *of Cornhill, in the City of London, Stationer; for a Method of preserving the Equilibrium, and preventing all Kinds of Carriages and Vehicles overturning.*

Dated December 19, 1807.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Williams do hereby declare that the nature of my said invention, and the manner in which the same is to be performed, are particularly described and ascertained as follows; that is to say: Instead of putting each pair of the wheels of the carriage upon one and the same inflexible axis or framing, having extreme parts answering the purposes of an inflexible axis as is usually done, whereby the said wheels in each pair are made to preserve an unalterable position with regard to each other; I do substitute in the place of each of the said inflexible axis or parts answering the purpose of the same, a pair of levers proceeding or projecting horizontally on each side, in opposite directions from the same part of the perch or middle bar, or framing made use of to connect the wheels of and belonging to the said carriage, and at right angles to the line of traction; and I do join or connect each of the said levers to or with the said perch or middle bar or framing made use of to connect the said wheels, by means of an hinge or any other strong or well-made joint of the nature of an hinge, so fixed and applied, that each of the said levers shall be allowed to move in a vertical circle, or up and down, but not at all sideways; and upon the extremities of the said levers, which are formed into pivots or points of the

axle of the usual materials, I do put and secure my wheels. And further, I do support the body of the carriage upon springs of any fit and suitable figure, by causing the said springs to bear or act upon the said levers, to which I do in some constructions affix the same; and in other constructions I do cause the said springs to act or play with one end not fastened or fixed, and in this last case I do connect the said body with the framing beneath, by means of an upright bolt or pin, which leaves room for play or motion of the body up and down, to a greater or less degree as may be required, and of which play or motion the quantity may at pleasure be regulated, by an adjustment of the length of the said bolt or pin. I do also apply other springs to support the fore and hind parts of the said body, by causing the said springs to bear upon the perch or middle bar, or framing of the said carriage; but in four-wheel carriages the said back and front springs are not required, but may be used if preferable. And I do further declare, that the effect of the said levers and the interposed springs as hereinbefore described is, that whenever an obstacle or cavity shall present itself, or be met with in the road, to or by any one of the said wheels, the said wheel will rise over or be depressed into the same, without producing the same disturbance in the equilibrium, or endangering the oversetting of the carriage, in the same degree as would happen in like circumstances to carriages constructed without the use and application of my said invention.

In witness whereof, &c.

Specification

Specification of the Patent granted to JOHN WILKINSON, *of Bradley Iron-works, in the Liberty of Bilston, in the County of Stafford, Esquire; for a new Method of making Pig or Cast Metal from the Ore, which, when manufactured into Bar-Iron, will be found equal in Quality to any that is imported from Russia or Sweden.*

Dated January 23, 1808.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Wilkinson do by this present instrument in writing, under my hand and seal, describe, ascertain, specify, and declare my said invention to consist in making use of manganese, or ores containing maganese, in addition to iron-stone and other materials now used in making iron; and in certain proportions to be varied by the nature of such iron-stone and other materials.

In witness whereof, &c.

OBSERVATIONS BY THE PATENTEE.

The inventor is prevented from adding any material "remarks," or "account of experiments," as from the nature of the invention, and the terms of the specification, it is obvious that the proportions of the materials must be entirely governed by the experience of the peculiar nature and quality of the common ores usually employed, and of which scarcely any two are exactly alike; and the proprietor of any iron-work desirous of practising the method of the patent, will have to vary the proportions accordingly, until he finds the result answer his wishes. The metal made by Mr. Wilkinson, as described in the patent, produces iron not inferior to the best Swedish iron, whether for the purposes of making steel or otherwise; and he feels convinced that the discovery will be of great national advantage.

Specification of the Patent granted to HENRY CHARLES CHRISTIAN NEWMAN, *of the Island of Saint Christopher, in the West Indies, Clerk; for his Invention of a Cattle Mill for expressing the Juice of the Sugar Cane.*

Dated March 7, 1807.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Henry Charles Christian Newman do hereby declare that the nature of my said invention, and the manner in which the same is to be performed, are particularly set forth and ascertained in the following plans and descriptions; that is to say: Fig. 1. (Plate XII.) A A A represents a ring or circle of hard wood, stone, or cast-iron, either raised on arches or otherwise, or sunk below the surface of the ground, and commonly called in the West-Indies a pit-mill, which is to be in the centre of the aforesaid ring or circle. B B represents a cog-wheel on the spindle of the mill; C represents a socket on the top of the spindle, and precisely in the centre of it; D, Fig. 2, represents a gudgeon let down into the socket and turning on a pivot and steel plate at the bottom of it; E represents a horizontal shaft or lever firmly fixed as an axle in a heavy wheel F; this lever passes through an eye or ring in the gudgeon D, to the farther extremity of the cog-wheel B B, over which is the lantern-wheel or pinion G, also firmly fixed on this end of the lever. H represents a pole, on each side of which one or more horses are harnessed, which pole has a collar in which the lever turns; and thus, by this new construction, position, combination, and connection

Fig. 1.

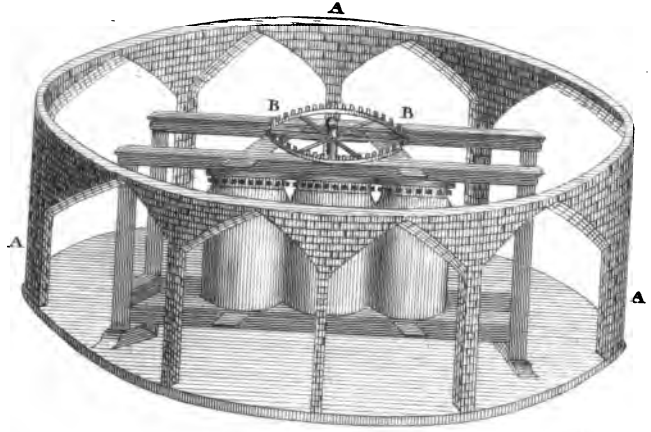
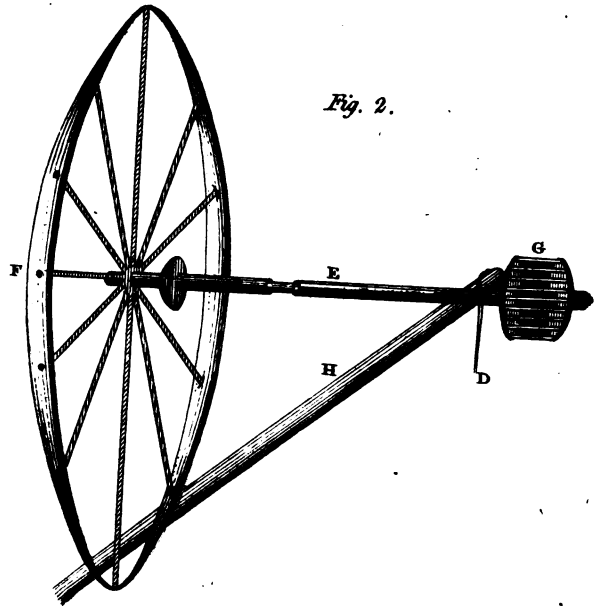


Fig. 2.



nection of the axis in peritrochio, the lever and lantern wheel or pinion put together like one solid and compact body, they all revolve together with two distinct motions; *viz.* a rotatory one on their own axis, and a progressive circumvolutionary one on the ring or circle, constantly acting upon and impelling the cog-wheel and spindle by their united powers and combined actions.

In witness whereof, &c.

Specification of the Patent granted to GEORGE SAVAGE, *of Huddersfield, in the County of York, Watchmaker; for a new Method of regulating or equalizing the Force or Power of the Main-spring in Watches or other similar Machines for measuring Time.*

Dated January 26, 1808.

With Engravings.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said George Savage do hereby declare, that my said invention is accomplished by introducing a minor spring, to be wound up by the major or main spring at certain periods. The drawing in the margin of these presents exhibits a method of effecting the desired end: it shews that, as the wheels revolve, the pins placed in a small circle in the hour or centre wheel, as denoted by the dots at A, Fig. 1. (Plate XIII.) force up at certain periods, according to the number of pins inserted, a lever *b* which is connected with the detent or small pallet *c*, and thereby unlock the quarter-piece *d*, Fig. 2, which covers the minor-spring, and the lever *b* is brought again to its proper place by the pressure of the spring *f*. This operation

operation causes the major or main-spring to wind up the minor-spring situated, according to this drawing, under the quarter-piece, and administers an equal impelling power to move the train of wheels: *e* exhibits a bridge, the same as is commonly used in watches, made to denote seconds of time, upon which the minor-spring-barrel moves. In witness whereof, &c.

Mode of constructing the recoiling Scapement.

Communicated by Mr. ROBERT KING, *of Scarborough.*

In a Letter to the Editors.

With an Engraving.

Gentlemen,

HAVING perused, in the seventh number of the "Retrospect of Philosophical, &c. Discoveries" an account of the construction of the wheel and pallet for Graham's dead-beat escapement, but which is erroneous in the opening between the pallets, no allowance being made for the motion of the pendulum; and as the Editors of that work, in their remarks on that account, express a wish that some person of established judgment and considerable practice, would in like manner lay down rules for the construction of the teeth and pallets of other most approved escapements, I have transmitted you the following:

To give a maintaining power to perpetuate the vibrating motion of pendulums in the most equable manner possible, has always been one of the desiderata among mechanics. And the angle of the inclined plane on which

which the teeth of the wheel acts, has not been agreed on by the several artists employed in the making of clocks and watches, or other time-pieces. The angle of sixty degrees has been generally used; but with recoiling pallets acting on a tooth during the recoil, the complement of the angle will in that case be the angle of the inclined plane, which, being only thirty degrees, will not push back the maintaining power with equal ease during the action of the pendulum on the wheel, as it is pushed forwards for the maintaining of the motion; and consequently, every vibration of the pendulum is checked, and not suffered to have its full swing, and yet gives no correction thereby towards the isocronisme of the motion, or equalization of the times of the vibrations. Now, to give the pendulum the greatest freedom of swing with recoiling pallets, the face of the pallets ought to be at the angle of forty-five degrees to the tangent of the acting tooth or point in every part of its action; or at least to the point where the action begins. This angle was adopted by Mr. Henry Hindley of York, as may be seen by examining the scapements of clocks made by him. To draw this scapement, having drawn the wheel, and divided it into the number of teeth proposed, of the same size you intend in the work (which in the example here given is a wheel of thirty, that number being most common for a pendulum beating seconds) you next consider the number of teeth between the planes or faces of the pallets, which in this figure I have made seven and a half, as may be seen by counting the spaces which will be the distance between the points *a*, and B, in the periphery of the wheel. (See Plate XIII. Fig. 4.) Then from the centre C draw the lines C *c*, and C *d*, through the points *a*, and B, which will be two radii at

at the angle of 90° or 7 teeth and a half. Then to these lines draw the perpendiculars *a* D and B D intersecting each other in the point D, which is to be the center of the verge; then through the point *a*, with the angle of forty-five degrees to the line *a* D, draw the line *g h*, which will be the line of the face of that pallet; then from the centre C draw the line C *f*, at the distance of half a tooth from the point *a*, and with the distance *a f*, set off from the point *a*, it will give the point of the pallet *e*; then draw the line D *e*, which will give the angle *e* D *f*, or the angle of impulsive swing, which is equal to the distance to be set off from the point B to *b*, which set off from B along the line C *d*, give the place in the face of the other pallet, where the tooth *i* will strike it next after the escape: at this point *b*, the face of the pallet must be drawn at an angle of forty-five degrees from the line *b* D, so that the point of the pallet may be free from the circumference of the wheel; for, when the point of the tooth at *a*, shall have slided along the face of the pallet to *e*, where it escapes the pallet, then the point *b* will, by the elevation of the point *e* of the other pallet, be brought into the line of the circumference of the wheel, and meet the point of the tooth *i*, which will recoil upon it, until the force of the pendulum is lost, and it is again acted on by the pallet, and so proceed to the point of escapement, where it quits the pallet at the same distance from the verge. In these pallets the line of impulse is equal in each pallet, and the pendulum has the same power on the wheel in the recoil, as the wheel has on the pendulum by its forward action on the pallet; and the wheel acts with equal force on each pallet, as being at equal distance from the verge. And the pressure of the wheel against the pallet

Fig. 1.

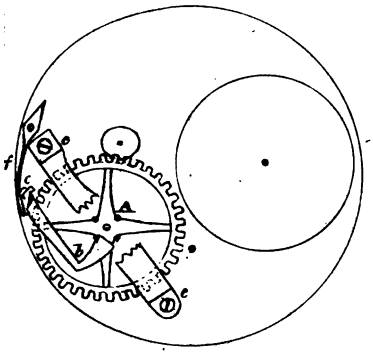


Fig. 2.

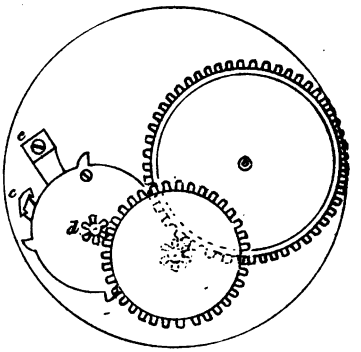


Fig. 3.

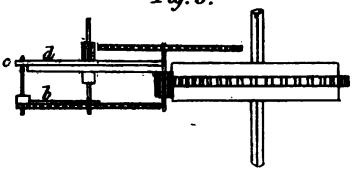
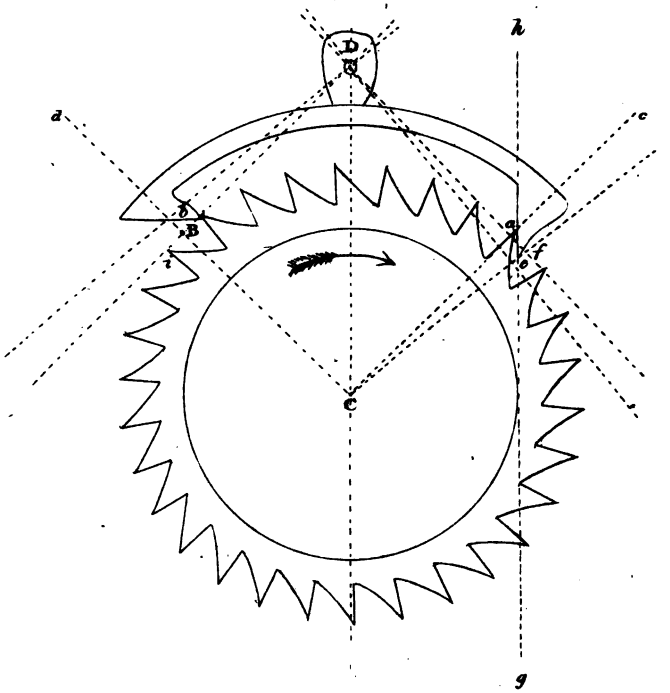


Fig. 4.



let being always equal, this escapement may be looked on as a very good one, only the tooth *i*, in its action, approaches towards D, when the tooth at *a*, by sliding along the pallet, recedes from D; so the power of the action of the wheel decreases while acting on one pallet, and increases during its operation on the other. Yet on the whole these pallets are best for common purposes, only the vibration is great. This scapement may be further improved by taking away the recoil, when it becomes superior to Graham's.

I have only to observe that what is wanting for the more perfect ascertainment of time is only the equalizing the impulse, correcting the expansion, simplifying the machinery, exact measuring the smaller portions of time, equalizing the divisions of instruments by the least complex measures or methods of machinery, all compound though detached scapements being most subject to error.

The expansion balance is the invention of a hatmaker of this place; it was employed by him as a perpetual motion.

Very few of the inventions of Mr. Hindley have been published, save what have appeared in the Philosophical Transactions, as communicated by Mr. Smeaton, who, I am confident, was never acquainted by Mr. Hindley with the real principles by which he made the instruments for equalizing his dividing engine, which was infinitely preferable in its original state to any now in being, although Mr. Smeaton thought Hindley over-rated its accuracy.

Remarks on Pruning Fir Trees.

By Mr. ROBERT SALMON, *of Woburn, Bedfordshire.*

With a Plate.

The Silver Medal was voted to Mr. SALMON *for this Communication.*

HAVING had the care for some time past of fir plantations, and knowing how much they are increased in this kingdom, I considered it as a matter of importance that a proper mode of management should be generally known, in order to bring timber to the greatest attainable perfection. For this reason I have turned my thoughts to the subject, and am confident that much may be done, as is elsewhere asserted, by good management. I have collected several specimens to demonstrate the difference between good and bad management, and have made some observations which I have not before met with, and may perhaps be useful.

Reference to Plate XIV. shewing specimens of English grown Fir Timber, cut out of his Grace the Duke of Bedford's plantations at Woburn, pointing out the impropriety of leaving timber to the course of nature, and the loss and defects that arise from such mode of management; also illustrating the necessity of some fundamental rule for managing the same, and the advantage of early and close pruning off superfluous branches, with a general rule for performing the same, and regulating the distance of the plants in Fir Plantations.

Fig. 1. Section A. shews a dead knot and progress in the growth of the tree, having 19 years of growth below

below the bough, and 18 years above it. From the regular course of nature, as shewn by this section, it is evident this bough or knot must have existed as long as the upper part of the tree, namely 18 years. For the first three years the growth and accumulation of the bough proceeded regularly with the tree; but about that time (now 15 years ago) the bough must have been distantly cut off, thereby preventing its regular increase in the part left remaining; for six years after cutting off, it appears to have barely existed, and after that ceased to exist at all but as a dead bough. Since it became so, nine years of accumulation has taken place on the trunk of the tree, thereby gradually inclosing a part of the dead bough, which part so inclosed is what by joiners is properly called a dead knot; the boughs that exist and are inclosed whilst living, are the live knots, and these the tree will produce either as the bough may be distant or close cut from the tree. From this specimen may be determined, that if the bough had been cut close to the tree at four years growth, there would now have been sound clean wood over it to the outside: or when it was cut, if it had been taken off at ⊕, sound clean wood would have formed over it to the outside.

N. B. In all the specimens this mark ⊕ is affixed to point out the proper place for cutting off, and is so placed as to allow for thickness of bark at the time it should have been cut.

Section B. shews a striking instance of the impropriety of leaving the smallest bough cut at a distance from the tree; this bough was cut off, and became stagnant at two years growth, notwithstanding which it was 14 years before the wood on the trunk accumulated to the end of the dead knot.

Had this bough been cut at ⊕, the knot as far as that would have been firmly united with the tree, and above it all sound clean wound.

Fig. 2. Section C, another instance of improper cutting.

If it had been cut at ⊕, the timber would have been more valuable.

Section D, this before cutting exhibited a healthy bough, and the section shews it the same, exhibiting a live knot. This specimen clearly shews the progress of nature in healthy boughs; it also shews the great impropriety of suffering such boughs to exist more than five or six years, at which age, had it been cut off, instead of a knot and great defect there would have been clean wood from ⊕ to the outside.

Fig. 3. Section E, another striking proof of the impropriety of long cut boughs, a dead knot of many years standing, but far from being inclosed now, admitting wet into the heart of the tree: it should have been cut off at ⊕.

Fig. 4. part of another Scotch fir.

Section F. a very striking proof of young and bad pruning. This bough was cut at four years growth, and now, after 18 years accumulation of the trunk, remaining uncovered, and would so have remained many years longer.

Section G, a bough which, whilst standing, appeared not vigorous or healthy; the section shews that at six years it was in decline, and after that increased very little, though its increase may be distinctly traced to the present time.

This should years ago have been cut off.

Fig

Fig. 5. a very complete specimen of good pruning, though much too late.

Section H, a large bough cut off at six years growth, but so close cut, that in four years afterwards the wood on the trunk of the tree is arrived at the extremity of the knot.

Figs. 6 and 7, parts of a Weymouth Pine Fir, 31 years growth, a most striking specimen, and complete refutation to the doctrine of those who contend that the best way is to leave plantations to prune themselves. This tree grew near the outside of a thick plantation securely fenced, and in a state of nature at the time it was felled, except some accidental breaking off a few boughs near the bottom of the tree. Before it was felled it indicated sickness by the foliage, but from what cause it was so, no trace appeared, as the trunk bore a very healthy appearance. The section shews, by the small increase of wood for the last six years, that it was not then healthy.

Section I, a dead knot from a bough broke off at six years growth; since which 25 years growth of wood has formed on the trunk, without nearly covering the stump; this stump was broke off before representation.

Fig. 7 is a horizontal section of three other knots cut from the same round as Fig. 6, shewing the great obstruction to the growth of the tree round the knots: this also explains the cause of the great hollow round the knot in Fig. 6.

The knot at K is a most striking and undeniable proof of the impropriety of leaving the smallest bough for nature's disposal. This bough protruded beyond the tree some distance, and evidently never existed but in a stag-

nate

nate state, for the last twenty-nine years; it being only two years old when it so became stagnate.

Fig. 8, a piece of the same tree as Figs. 6 and 7; but from the next higher tier of boughs, having a small piece wasted between the two.

Section L, two small boughs, the upper one only one year's growth, was twenty years before covered, and has nine years wood over it. The lower bough is of six years growth, was twenty years before covered, and has four years wood over it.

On contemplating these specimens; considering the purposes that fir timber is generally applied to, and having some knowledge of plantations of this sort, it must occur that clearness of knots, straightness, length and equal size of its trunk, constitute its perfection; and, if deficient in all these, it is of no value but for the fire. Next to these considerations, and the prospect of an improved knowledge of cultivating this article, it may be a fair question, if our own country is not capable of producing fir timber little or not at all inferior to the foreign fir.

At present fir in this country appears not for any period to have been considered much otherways than as ornamental. For this purpose they serve but for a certain time, which past, it has been their fate to be cut down, long before having attained maturity. But from the vast plantations now established, it is to be hoped that another century may obtain to English fir some of the character of the English oak; towards such end, if attainable, every means should be used, and towards which nothing appears more likely to succeed, than a well-grounded general practical mode of management, from the time of their being planted out, to their greatest imagin-

imaginable age of improvement. That a knowledge of such may by perseverance be gained, is not much to be doubted; and by inspecting and considering the specimens herein referred to, there appears great reason to conclude, that early and proper pruning and thinning will form a considerable feature in the system to be adopted.

Now as forms are first instruments in good systems, and that proceedings on fundamental principles (though in the essay they may a little err) are better, in a general view, than occasional success by hazard; so it may be warrantable that a system for general management may be laid down, although the author cannot possibly have lived to prove all by experience: so the rules hereafter submitted are given, being the result of only a few years observations.

For planting, from every authority or observation, there can be no doubt that all firs should be planted thick; not more than four or five feet apart.

Where firs of the same kind are planted together, there is less loss of plants from one sort overgrowing and destroying the others; consequently it appears advisable that all the different sorts be planted by themselves. If any admixture be at all admitted, the Scotch and larch may best succeed: but this is not certain, and they will certainly be best separate on two accounts; first, because they are not so likely to injure each other; and secondly, the larch may be put in the ground best suited to them, and the Scotch the same.

In making plantations of any particular sort, it may be right to have a few spruce, or other sorts on the outside, to prevent mischief from sudden gusts of wind; but if the situation is not subject to such gusts, the spruce had better

better be omitted, being mechanical agents only, and by excluding the sun and air they act against the operation of nature.

In these hints ornament is not considered; if such be wanted, and profits also, then the spruce, larch, silver, and some other may be combined.

From some years observations on pruning and the effects thereof, it appears certain that fir-trees, at a certain age, should be pruned to a certain height; and for regulating thereof, the following simple rule is recommended. The pruning to commence when the trees are six years old, or when there is discernible five tier of boughs and the shoot; the three lower tier of boughs are then to be taken off. After this first pruning, the trees to be let alone for four or five years, and then, and at every succeeding four or five years, the pruning to be repeated, till the stem of the tree be clear to forty feet high, after which, as to pruning, it may be left to nature. The rule for the height of pruning, after the first time, to be half the extreme height of the tree, till they attain twenty years growth; and after that time, half the height of the tree, and as many feet more as it is inches in diameter at four feet from the ground. This pruning is known from repeated observations, not to be excessive, and the rule is calculated to check the too tapering top, and strengthen the slender bottom by carrying the pruning to a greater proportionate degree, in a ratio compounded of the height and bottom bulk; and by this rule it may be observed, that the trees will be at top cloathed with somewhat less than half their branches. The proper time for pruning, is between September and April, and the tool to be used, the saw.

Orderly

Fig. 1.

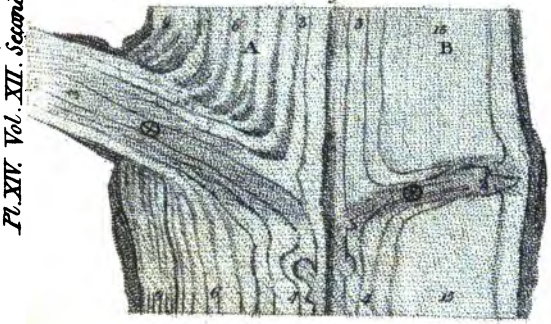


Fig. 2.

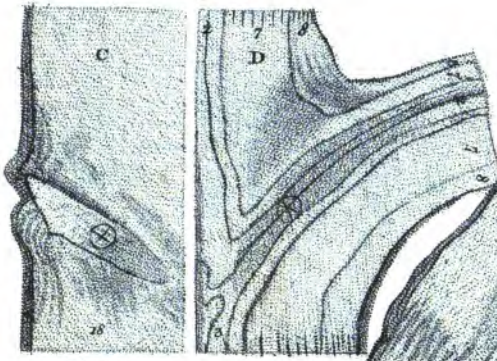


Fig. 3.

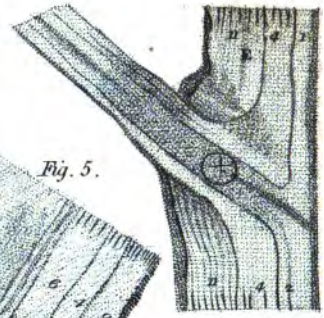


Fig. 5.

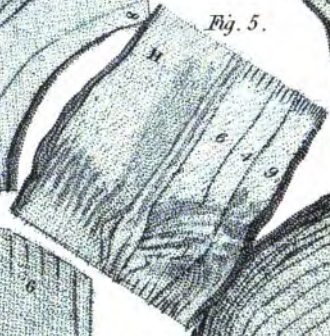


Fig. 4.

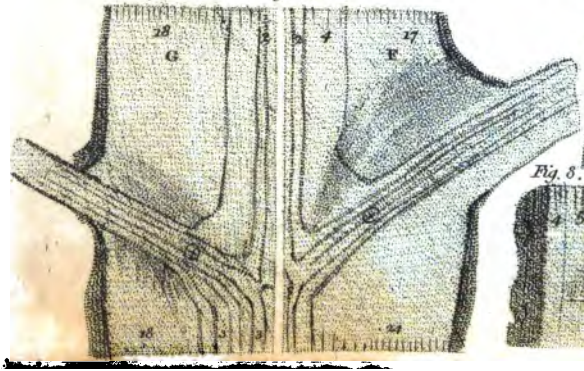


Fig. 6.

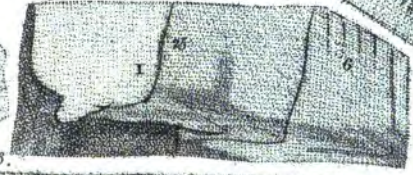
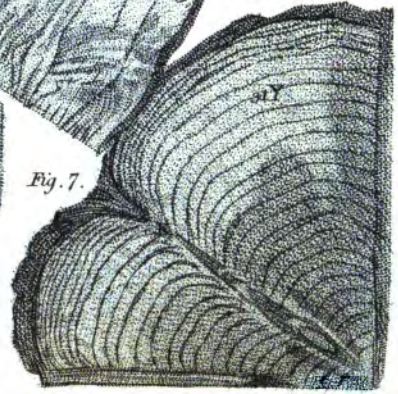


Fig. 8.

Fig. 7.



Orderly thinning the trees at certain periods is the next essential to pruning, and for this purpose observations have been made on the most orderly and thriving plantations, and the following simple rule is recommended. Keep the distance of the trees from each other equal to one-fifth of their height! In the application of this rule for thinning, it is evident that each individual tree can never be made to comply, for the original distance (even if planted in the most regular order) will allow only of certain modifications, by taking out every other tree, and so on; but even if the obtaining such equal distance was practicable, experience would shew that another way should be preferred, of which the eye must be the judge, by taking out such trees as are least thriving, stand nearest another good tree, &c. &c.; at the same time keeping in view the rule prescribed: the following of which rules may easily be proved by measuring a chain square, or any quantity of the land, and counting the trees thereon; then by trying the height of two or three trees in that quarter, and taking one-fifth of such for the distance, it would be readily seen how many trees should be contained in the piece measured; or the practice may more simply be regulated, by taking the distance of eight or ten trees added together, the average of which should be equal to a fifth of the height of the trees.

In these rules nothing impracticable or complicate is proposed.

The author has for years known the expense, and produce from trimming only, and finds in Bedfordshire the produce doubly repays the expense; and although some experimentalists may differ from him, or time may shew some reason for deviating somewhat from his rule, yet it

is presumed all will agree that some simple system is advisable, instead of having plantations and woods mismanaged, to the great loss of the community and the proprietors. If such a system as proposed be generally promulgated; if not perfect, it will most likely, in time, become so, and thereby have its advantage; and that some advantage may be had in speculation, the following concluding remarks are introduced.

In the common course of gardening, it is understood that pruning invigorates the tree; that trimming off the side branches makes the upright ones shoot the stronger, and by cutting out the dead and decayed wood the tree is kept alive: some of this doctrine will certainly apply to the tribe of firs; it will certainly substitute clean wood for knots, and of all this treatment, from their particular uses, they of all other trees stand in most need, and will be most improved by it. And should it be admitted that like treatment would on the fir, as well as other trees, produce the like effect, it would lead to a well-grounded expectation that, as well as producing clearness from knots, straightness and length, the same operation would advance the quality nearer to that of foreign fir; for it may be traced, that where trees are tall and clear of boughs or knots, the whole substance of the wood is better and of finer grain, and it appears likely that such will always be the case: the reason may probably be inferred from the sap having farther to rise and descend, and having no boughs to divert or delay it, the circulation must be more fine and rapid, most increase be left in the neighbourhood of the boughs at the top of the tree, and least on the sides at the lower part; consequently adding to the length of the head, and rendering

dering more fine each annual increase to the body; thereby producing a close-grained, clean, long, and regular, easy-tapering useful piece of timber; instead of a coarse-grained, short, sudden-tapering trunk, with a quantity of boughs and knots.

The foregoing observations and rules are meant to apply to fir timber only, but to a certain degree they may be applied to other timber; though by no means to the same extent, or age. But if applied as far as the first fourteen years of their growth, and then the pruning altogether omitted, and the thinning-out very much increased, any plantation would be rendered much more valuable than if left entirely to nature.

I hereby certify that in the year 1804, having directed Mr. ROBERT SALMON to collect proofs as to the advantage of pruning and managing my fir plantations in this neighbourhood: accordingly, in January 1805, he produced several specimens, with his remarks thereon; both of which, I am of opinion, do convey a proof of the necessity and utility of attention and management in the growth of fir, and of timber in general; and such specimens I think likely to be useful to the public, and worthy the attention of the Society for Encouragement of Arts, Manufactures, and Commerce.

BEDFORD.

Woburn Abbey, March 22, 1806.

To Dr. C. TAYLOR.

Method of cultivating Hemp.

From a TREATISE *on* HEMP *by* ROBERT WISSET, *Esq. F. R. and A. S.*

THE first and most considerable ploughing or stirring is given to the Hemp-ground in the months of December and January, and is called the winter-ploughing or stirring. Some use for this purpose the common plough, laying the ground rough in furrows: others use the vineyard-hoe, likewise forming furrows, that the ground may be the better mellowed by the winter's frost. Some even dig it with the spade, which is certainly the best method, but more tedious and laborious; while, on the contrary, ploughing it is the most expeditious, but the least profitable.

In the spring, the ground is thoroughly prepared for the receiving of the seed by two or three ploughings or stirrings; and a fortnight or three weeks should intervene between each of these ploughings, making them gradually slighter, and laying the ground smooth and even.

In these spring-stirrings, as in the winter one, either the plough, hoe, or spade may be used.

If after all these ploughings or stirrings, any lumps or clods of earth remain, they should be broken by the hand with mallets; for the whole hemp-ground should be as level, and of as fine mould, as the beds of a garden.

All the manures that render the earth light are proper for hemp; and accordingly the dung of horses, sheep, pigeons, and poultry, or the scouring of the ponds in villages, when it has had time to ripen, are preferable to cow-dung. Marle is not, to my knowledge, used for the manuring of hemp-grounds.

It

It is best to dung the hemp-ground every year, and before the winter-ploughing, that the dung may have time to rot during that season, and that the spring-ploughings may the more thoroughly mix it with the earth.

Pigeons'-dung is the only one which, in order to derive the greater advantage from it, is put in the ground during the spring-ploughings. It is to be feared, however, that, if the spring proves dry, the pigeons'-dung may burn the seed, which it would not do, if laid on during the winter: but in this case, a greater quantity of dung should be used, or less advantage must be expected from it.

As soon as the hemp-seed is sown, it must be carefully covered with earth; either by means of a harrow, if the ground has been ploughed; or with a rake, if it has been dug by hand.

Notwithstanding this precaution, the hemp-ground must be constantly and assiduously watched, till the whole of the seed has risen; for otherwise numbers of birds, and especially pigeons, will destroy it entirely, without sparing even the seeds which have been well buried. It is true, that pigeons and birds which do not scratch, do no great hurt to the grains of corn that are well covered with earth: but the husks of these grains do not rise up out of the ground with their green shoots, as those of hemp always do; and then it is, that these birds, mistaking them for perfect seeds, tear them away with the young plants to which they adhere, and thereby commit vast havock.

The farmers endeavour to frighten the birds away with scarecrows, and cause their children to watch the hemp-grounds. But these precautions are found to be insuffi-

cient;

cient; for this is a very laborious task when the hemp-grounds are large, especially if the pigeons, which are so greedy after it, be hungry. I have seen strong men, and even dogs, so wearied out with fatigue, as to be forced to give up the task. Happily, this troublesome work does not last long; for when the hemp has put forth a few leaves, it requires no further tending.

After the plants have come up, the hemp-grounds require very little care or labour till the gathering of the produce. In general, it is deemed sufficient to keep the ditches in order, and to prevent the cattle from entering them.

In very dry seasons, however, some industrious farmers water their hemp-grounds by the hand: but this is not practicable, unless the grounds be small, and the water be near at hand: or they may be watered by immersion or overflowing, as I believe is done in some places.

If, by any accident, the hemp grows very thin, so as to be thereby in danger of branching out too much, and becoming woody and incapable of furnishing good fibres, it will be advisable to keep it perfectly clear of weeds, in order to let it remain for seed, which will be so much the better for the plants having stood thin; and thus, at least, some advantage will, in such cases, be derived from the hemp-grounds. *Du Hamel.*

Some people give the land only one ploughing for hemp, which is just before they sow it: but others prepare it as finely as the gardeners do their mould. For this purpose it should be ploughed once in the preceding autumn, and two or three times in the spring; and after the first spring-ploughing in February it should be well manured. *Chambers's Dictionary.*

The

The ground on which hemp is designed to be sown should be well ploughed, and made very fine by harrowing. *Encyclopædia Britannica.*

After you have made choice of your ground, break up about the beginning of May, in a fair season, with a strong plough, such as is generally used in all strong clay grounds, the share being rather long than broad, and the coulter rather somewhat bending, than straight and even, according as the nature of your ground shall require, which you will soon find out on turning up two or three furrows; for, according to the cutting of the earth, you must fashion the temper of your plough. To plough your land well, you must throw down your furrows flat, and betwixt every furrow you should leave a baulk of earth, half as broad as the furrow, and so go over the whole of the ground, without making any difference or distinction of lands. But if you fear any annoyance of water, then you should lay your furrows higher, nearer, and closer together, dividing the ground into several lands, and proportioning every land to lie the highest in the middle, so that the water may have a descent or passage on each side.

The ground where you sow your hemp should be like that where you sow barley, or at least as often broken up as you do when you fallow for wheat, which is thrice; except it be some very mellow and ripe mould, as hemp-lands usually are; and then twice breaking up is sufficient, which must be done about the latter end of February, and the latter end of April.

Seasonable Advice for England's Improvement.

Hemp

Hemp should be sown after a fallow or green crop; and as this plant is of a vigorous growth, it must be laid down with manure plentifully. It ought to be ploughed deep before winter, and frequently in the spring, that it may be mouldered as much as possible before sowing.

Sinclair.

In Suffolk, hemp is in the hands of both farmers and cottagers: but it is very rare to see more than five or six acres in the occupation of any one man. With cottagers, the more common method is to sow it every year on the same land. There is a piece at Hoxne which has been under this crop for seventy successive years. They manure for it with great attention; so that it may be taken as a maxim, that hemp is not often sown without this preparation. Of dung and moulds it requires twenty-five three-horse loads for an acre: of dung alone, sixteen are sufficient. This is done directly after wheat sowing is finished.

The tillage consists in three earths, with harrowing sufficient to make the soil perfectly fine; and it is laid flat, with as few furrows as possible.

The Rev. Mr. Mills, of Bury, observes, that the land should be well worked, and manured with thirty loads per acre, about a fortnight before seed time.

Hemp may be grown with success on the same land many years by manuring annually. *Suffolk Report.*

At Swineshead, in Lincolnshire, where much hemp is grown, it was formerly cultivated on the same spots year after year; but now they spread it over a farm, accordingly as the soil suits or the price actuates; and on some lands that are foul they sow it as a cleanser. If the soil

is

is weak, they manure for it. It is ploughed first at Candlemas; a second time at Lady-day; and a third time about the middle or end of May, previous to sowing.

At Haxey it is sown after wheat. Some plough before Christmas; others at Candlemas. After the first ploughing, the ground is manured. Some turn it in; but this is not so good. A middling dressing, the shorter the better. The best dressing is pigeon's dung, added to dung, a quarter, or a quarter and a half per acre. It answers best after wheat that follows clover. The ground should be ploughed again between Candlemas and Lady-day, three or four times, and well rolled and harrowed.

Lincoln Report.

Dung is by no means necessary to the growth of hemp; but good tillage and a suitable soil is absolutely so. The mould should be deep and easily penetrated; for the fibres of the roots are soon checked, and, if impeded, are no longer capable of performing their proper offices. *Complete English Farmer.*

In the northern parts of Europe, as Poland, Prussia, and Russia, the most infallible mode of ascertaining when the soil is of a proper degree of strength, is by raising previous crops of other grain.

On a vigorous soil, in a good state of cultivation, the usual rotation of crops is: 1st. winter-wheat; 2d. winter-rye; 3d. barley; 4th. oats; and then hemp. Such a soil will bear a crop of hemp without being manured: if manured after the first, it will give a second. But on a soil of less strength, a crop of hemp is taken immediately after the winter crop of rye; the land being

ploughed up once, either in the intervening autumn or spring, harrowed and manured in the spring, and then ploughed over a second time for sowing.

To make the most of this poor soil, a winter crop of rye is sown immediately after the hemp has been drawn, without any further manure. *Durno.*

Land intended for a crop of hemp must be well manured, well ploughed, cleansed, and gotten fine.

L'Abbe Brulles.

Hemp-grounds must be dunged every year, and the better to secure success it would be proper to lay on the dung before the winter tillage, that it may waste itself there, and mix the more perfectly with the ground, which, impregnated with these new salts, will derive the greater advantages from the influences of that season, and catch more of the volatile salts of the air, that commonly abound most in the winter.

Of all the sorts of dung that are used for hemp-grounds, pigeon's dung only, or any other kind of dung that is fully ripe, ought to be laid on before the last labour, as is practised with success in several places. In countries where the land is strong, they generally lay it in heaps after autumn. In this manner it becomes more free and light than when it is only tilled. The snow and rains which penetrate it in the winter time, and the frosts that are common in that season, kill, if we may so express it, that ground, as they would a chalk-stone, and make it so free, that in the month of February nothing more is wanting but to lay it level by a quick and easy labour. All its parts, and even the most tender particles, will then be found extremely small, light, and lively.

But

But different soils require different methods of preparation; and it is the part of men of understanding to discontinue bad customs, that have prevailed till this time, and substitute better methods in their place.

Marcandier.

The ground should be made rich with dung, and for the conveniency of pulling the male or early hemp (without hurting the other), as well as giving it air, I would sow it in drills, or small ridges, about three feet broad, with two feet intervening between the ridges, that a person may go up and down amongst it, without trampling upon the seed-hemp.

It grows best when sown repeatedly on the same ground, provided it be well dunged every three years.

M'Donald's Essay.

If the ground has not had a previous summer fallow, it should be ploughed once in the autumn and twice in the spring: it should then be harrowed extremely fine with iron-toothed harrows. *Taylor's Instructions.*

Mode of Cultivation in Bengal.

Instead of sowing the hemp *(Cannabis sativa)* very thick, as it ought to be done when the plant is intended for cordage, the natives sow it very thin, and afterwards transplant the young plants, placing them at a considerable distance from each other, often nine or ten feet. By this mode the plant grows to a very large size, a great deal too large to admit of the stalks beng properly bruised for heckling. This mode of cultivation is too expensive, if used with the view of preparing cordage from the plant.

There can be no doubt, that the Ryotts, if due encouragement were held out to them, would readily adopt the European mode of cultivating the hemp, and also of dressing the fibre for cordage. A native, who had an opportunity of observing the mode of cultivating and preparing the hemp raised by Mr. Douglas at Rishera, has offered to the Board of Trade to contract with them for supplying a very considerable quantity, I believe five hundred maunds *, of properly dressed hemp next season, at the rate of ten Sicca rupees per maund †.

Dressed hemp might probably be soon procured at eight Sicca rupees per maund, or £28 per ton, but hardly at a lower rate, at least for some time.

When the mode of cultivation is better known, and the Ryotts find they have a certain market for their produce, it is probable they may be able to afford the dressed hemp at a much lower price.

The ground must be manured, and repeatedly ploughed and harrowed. *Mr. Fleming.*

The seeds should be sown as thick as the natives commonly sow the sunn, on a rich free soil. The ground should be well manured, and repeatedly well ploughed and harrowed. *Mr. Douglas.*

The mode of cultivation practised by the native differs materially from that requisite for the purpose of raising hemp; and they are notoriously wedded to their own customs and habits, and averse to innovation of any kind.

Minute of the Board of Trade.—Board of Trade Cons. 5th May, 1801.

* About seventeen tons.

† This is equal to 300 Sicca rupees, or, at 2*s.* 6*d.* per rupee, 25*l.* per ton.

Sunn.

Sunn.

Benares.—The ground is ploughed over once or twice in the month of June, or at the commencement of the rains, and when it is thus prepared and moist, the farmer watches an opportunity, when he thinks it likely to be fair clear weather for a few days, to put the seed into the ground. If in this he is not disappointed, the young plant will begin to make its appearance in three or four days after the seed has been sown, and it will afterwards require but little attention, as the usual rains, without any other assistance, are sufficient to bring it to maturity But should the farmer be not successful at the time o putting the seed into the ground, and heavy rains com on, before it has had time to take root, the consequenc is, that it will rot, and he has lost his labour. At th close of the rains, or about the end of September, th Sunn is ready for cutting. When the farmer is cutting he will leave standing a small quantity, perhaps about quarter of a begah out of ten begahs, to grow to seed and that is cut about the end of October. Afterwards he will prepare the same ground for barley, wheat, or some other grain, but in general the two former, and thereby have two crops from the same ground, between the month of June and the middle of March.

Malda.—In the month of September, the ground must be first of all twice ploughed and then once harrowed; after which it must be again twice ploughed and once harrowed; all the clods of earth beat fine, and well cleared of weeds. In this state it is ready to receive the seed. After sowing it must be twice ploughed and twice harrowed. This is the practice with ground which has been recently in cultivation with other articles; but in case the land to be cultivated has lain fallow during several

veral years, more labour must be bestowed upon it, and instead of being ploughed six times it must be ploughed ten times.

Such is the mode of cultivation generally practised in the different districts round the factory: but in the country adjacent the seasons of sowing and reaping are quite different, and the cultivation is performed after the following manner:

The ground being prepared, as before, with four or more ploughings, as circumstances require, and being well cleared of weeds, the seed is sown in Jeyse Assar (June), after a fall of rain, and the ground must upon this be ploughed and harrowed. When the plant has grown about nine inches from the ground, it must be weeded. It must again be weeded when the plant is a oot and a half, or two feet high. The Sunn being ready, hich happens in Bhaddar Asseen (September), is cut lown, and not pulled up by the roots, because from rowing in the rainy season the stalks are much larger nd stronger. Some cut it in flower, some in seed. The Snn being cut is left three or four days in the field, dring which time the greater part of the leaves drop off. Te last mentioned Sunn, which is cut in September, is bo finer and stronger than the other.

ommercolly.—There are two kinds of Sunn, which are cultivated at different seasons of the year, though they are nearly similar in quality; one being sown in June, the other in October. That sown in June is generally cut about August, and the other about April. The plant intended for seed is left standing fifteen or twenty days longer, when it is cut, and, after being thoroughly dried, the seed is taken from it by threshing.

Hurrial.

Hurrial.—In the month of January the ground is ploughed and well harrowed: in February it is again ploughed. In April, after the first shower of rain falls, it is a third time ploughed and well harrowed, to clear it from weeds, and the following day the seed is sown by the hand (in the same manner as the English farmers do wheat, &c.) and then again well harrowed. In a few days it appears above ground. When it has got to the height of about eighteen inches, the ground must be well weeded; after which nothing further is required to be done until the month of August, by which period it is at its full growth (about five feet,) and the flowers make their appearance. It is then (except what is intended to be reserved for seed) cut down, as close to the ground as possible, and laid in ridges, care being taken to place them so, that the leafy parts lie one upon the other. In this state they continue ten or twelve days, or until the leaves begin to rot, and fall from the stalks on being shook.

Hurripaul.—It should be raised on high ground, where no water will lie. First, dung is thrown upon the earth; after lying ten days, it is ploughed; five days afterwards it is harrowed once; in two days more the seed is generally sown. The sowing never should be delayed beyond seven days. After strewing the seed, it is ploughed and harrowed. In three days the seed will begin to shoot, and appear plainly in four or five. No farther process is required, not even weeding; the Sunn being set so close, and growing so thick, that nothing else can easily come up. In a month and a half it will be seven feet and a half or eight feet high, at which time it bears a yellow flower. At this time it is cut down, except what may be left for seed, the fibre from which will be

inferior

inferior. The season begins about the 10th May, and the crop is gathered within two months. If sown every year in the same spot, the soil would be impoverished, and the produce inferior; the land is, therefore, every other year, appropriated to sugar, cotton, or early grain.

Rungpore.—About the month of March the cultivation of the land commences. It is frequently ploughed, cleaned, manured, and ploughed again for the space of a month; the soil being well mixed, broken fine, and laid smooth. The seed is strewed over the ground lightly in the month of April. In about eight or ten days the plants begin to rise. About fifteen or twenty days after, the ground is carefully weeded. When the plants have risen to the height of a haut, or half a yard, those which may have sprung up too close to each other are transplanted to more open parts of the field. When they have risen to the height of one and a half or two hauts, the ground is again weeded; after which they are left to ripen, without farther care. In about four months from the time of sowing, the plants will have arrived at maturity, at which time their height will be about five hauts. Those plants which are reserved for seed are generally allowed to remain a few days longer on the ground than the rest, till the seed begins to loosen in the husks. *Board of Trade, Cons, 24th Aug.* 1792.

DACCA DISTRICT.

Basetpore.—If the ground has lain waste any length of time, it will require to be many times ploughed, previously to the reception of the seed which is sown in Cautic (October): but if the ground be already in a state of cultivation, and has lately yielded an ouze crop of

of grain, it will be sufficient to plough it four or five times.

After the plants appear, the only care that is taken is to place Chokeys, to prevent cattle from injuring them.

About five months after the plants come up, on their being sufficiently mature, they are taken up by the roots, and tied up in bundles.

Dacca-Jelalpore.—The ground is ploughed seven or eight times, and the seed is sown in Cautic and Augun (October and November.)

When the seed is sown, the plants appear in the course of ten or twelve days, after which no farther care is bestowed upon them. Three months afterwards the plants are cut down.

Teetbaddy.—The ground should be ploughed five or six times, and the seed sown in Cautic (October), or until the 4th or 5th Augun (15th November).

After the appearance of the plants no further care is bestowed on them.

About four months after the appearance of the plants, or in the months Faugun and Chyte (February and March), they are taken up by the roots, and, the tops being taken off, are tied into bundles.

Momensing.—If the ground has been previously cultivated, three or four times ploughing is a sufficient preparation for the reception of the seed, which is sown in Cautic (October).

From the coming up of the plants, until the time of harvest, no farther attention is given to them.

The plants blossom in Maug or Faugun (January or February), and after blossoming they are cut down.

Chaundpore.—The ground should be ploughed and harrowed seven times, and the seed sown in Cautic or Augun (October, November). After the seed comes up, the plants are reared in the same manner as at Teetbaddy.

Five or six months after the coming up of the plants, in Faugun or Chyte (February, March), on the falling of the blossoms, the plants are taken up by the roots, and tied together in small bundles.

Serampore.—If the ground be already in a state of cultivation, it will only require to be ploughed three, and harrowed four times, previously to the sowing of the seed, which should be in Augun or Poose (November, December), and to be twice ploughed, and three times harrowed, after the sowing: but if the ground have lain waste any length of time, the ploughing and harrowing must be repeated oftener.

After the seed comes up, the plants are reared in the same manner as at Teetbaddy.

Seed sown in Augun (November) produces plants which are cut in Faugun (February). Seed sown in Poose (December) produces plants which are cut in Chyte (March). On cutting the plants, the tops are separated and thrown away.

Tipperah.—Previously to the sowing of the seed, which is done in Cautic (October), the ground is ploughed three or four times, and harrowed.

After the seed comes up, no farther trouble is taken.

In five or six months after sowing the seed, or in Chyte and Bysaak (March and April), the plants are cut down, and made up into small bundles.

Sylhet.—The ground is ploughed twice, and the seed sown in Cautic (October). After the appearance of the plants,

plants, no farther attention to them is necessary. In Faugun or Chyte (February or March), about four months after the sowing of the seed, the plants are cut down and made up into bundles.

Jungypore.—The ground designed for Ghore-Sunn is ploughed three or four times, and the clods of earth are broken and pulverised by a kind of harrow. The lands are ploughed twice in the dry season, in April or May. When the rains set in, they are again ploughed, and the seed sown when the land is as wet as the situation will admit.

The plants appear four or five days after the seed is sown, and, rising very quickly, require no weeding, as the plant soon overtops and destroys grass or weeds, by depriving them of nourishment: and as the seed is sown on the commencement of the rains, no watering is requisite, nor any thing farther to be done by the proprietor, until the plant is ready for cutting, which is from the 20th of September to the 10th of October, being sown in all June. The plant is cut when in flower, and bound up into bundles.

Keerpoy.—The ground being ploughed three different times, the seed is sown, by being scattered over the ground at pleasure, with the hand, in the month of Bysaak (April); and in Ausseen (September) the hemp is cut.

Patna.—The only preparation required for Sunn is to plough the ground four times transversely, after manuring it with wood-ashes and cow-dung, in equal quantities, in the proportion of about eighty pounds to a cottah, or square of about nine feet. The seed is sown in June, soon after the setting in of the rains. The ground must be kept free from weeds.

It grows six or seven feet high, and is cut down in November, about the time it begins to flower; and what is reserved for seed is ripe and cut in January or February.

Chittagong.—The time for sowing the Ghore-Sunn is in the month of Ausseen or September. Previous to its being sown, the ground is well manured with ashes, and ploughed, and then harrowed for nine or ten days together, until it is made as fine as garden mould. This done, the seed is thrown into the ground, or laid in rows, as fancy may direct, covering it over lightly with earth.

When the plant appears, which is generally in five or six days, it is frequently hoed, and kept free from weeds; and when it comes to maturity, which will be in about four or five months, it is pulled up by the roots, and tied up in small bundles.

Board of Trade Cons. 14th Jan. 1793.

In the cultivation of Sunn, the natives seldom pay much attention to the quantity and tillage of the land, it being a plant that will grow in almost every soil and situation; except in very low places, where it is apt to be much overflowed in heavy rains.

Mr. Douglas, Bengal Consult. 5th May, 1801.

Chittagong.—Sunn is cultivated and prepared in the manner stated by Mr. Douglas to be common in the other parts of Bengal.

Commercolly.—The ground is good paddy or mulberry land, and should be twice well tilled for Phool-Sunn, and once for Boggy.

Board of Trade Consult. 12th June, 1801.

BOMBAY.

BOMBAY.

Mode of Cultivation.

A good deal of hemp *(Crotolaria)* is annually cultivated in Salsette. It is generally sown on the sides of hills, as it would not pay for the expense of better ground. Its cultivation costs but little; the ground is slightly scratched by an instrument, when the seed is sown towards the end of the rainy season. It grows luxuriantly, without farther trouble, to the height of seven or eight feet, or more; and soon after the conclusion of the rainy season it is ripe.

There are vast tracts of mountainous ground in Salsette, where Hemp would grow to perfection; and there is also much uncultivated low land, on which it could be raised without interfering with the present agriculture of the country. It might be proper to let the people have such land as is employed in this cultivation free from rent. This encouragement, I think, would have the desired effect in the course of a few years; but I cannot suppose, that the people of that island will pay for the land in order to cultivate hemp, or that they will raise any quantity of it, which they do not see they can immediately dispose of to some advantage.

Letter from Dr. Helenus Scott, 31st May, 1803.

List of Patents for Inventions, &c.

(Continued from Page 160.)

WILLIS EARLE, of Liverpool, in the county of Lancaster, Merchant, for certain improvements in the tillage and dressing of land, and the cultivation of plants. Dated January 13, 1808. Specification to be enrolled within one month.

JAMES

James Lee, of Plaistow, in the county of Essex, Merchant, and John Perrin, of the same place, Esq. for their new mode of preparing certain kinds of hemp, by which the value and utility of the articles is much increased. Dated January 13, 1808. Specification to be enrolled within six months.

John Wilkinson, of Bradley Iron-works, in the liberty of Bilston, in the county of Stafford, Esq. for his new method of making pig or cast-metal from the ore; which, when manufactured into bar-iron, will be found equal in quality to any that is imported from Russia or Sweden. Dated January 23, 1808. Specification to be enrolled within one month.

Andrew Johansen, of Hommerton, in the county of Middlesex, Gent. for his improved methods of manufacturing a kind of tablet or artificial whetstone, for whetting or sharpening razors, penknives, Surgeon's instruments, and other cutlery, which he usually denominates "Cotific Tablets." Dated January 23, 1808. Specification to be enrolled within one month.

Edward Moore Noble, of Birmingham, Surgeon, for his new method of making of carbonate of lead, commonly called white lead. Dated January 23, 1808. Specification to be enrolled within six months.

Samuel Phelps, of Cuper's-bridge, Lambeth, in the county of Surrey, Esq. for certain improvements in manufacturing soap. Dated January 23, 1808. Specification to be enrolled within six months.

Thomas Preston, junior, of Tooley-street, in the county of Surrey, Lead Merchant, for his new method of setting boilers for steam-engines, pans for melting lead, tin, pewter, and other metals of easy fusion; and new mode of discharging the pans for melting lead, tin, pewter, &c. as before-named when full, and setting coppers

and

and boilers of every description. Dated January 26, 1808. Specification to be enrolled within four months.

GEORGE SAVAGE, of Huddersfield, in the county of York, Watchmaker, for his new method of regulating or equalizing the force or power of the main spring in watches, or other machines for measuring time. Dated January 26, 1808. Specification to be enrolled within one month.

WILLIAM STEWART, of Limehouse, in the county of Middlesex, Builder, for certain improvements in making bricks and tiles. Dated January 26, 1808. Specification to be enrolled within one month.

JOSEPH JOHNSON and JOHN WILMOT, of Birmingham, in the county of Warwick, Manufacturers, for their new kind of warming-pans, which are not only applicable to the purpose of airing and warming beds; but also for airing and warming rooms or carriages, or for other purposes requiring a long and protracted heat. Dated January 28, 1808. Specification to be enrolled within one month.

WILLIAM NEWBERRY, of St. John's-street, in the county of Middlesex, Gent. for certain machinery for the purpose of sawing wood, splitting or paring skins. Dated January 30, 1808. Specification to be enrolled within one month.

JOHN DRUNBELL, of Mersey-mills, in the parish of Warrington, and county palatine of Lancaster, Miller, for his method or methods of obtaining, producing, using, and cultivating a moving power or force, and of communicating motion to engines, pumps, and machinery, and to mechanical operations in general, and of forming and using a rotary or circular motion, or a motion to and fro, *ad libitum*; and a method or methods of working and applying

applying the same to mills, machinery, ploughs, tools, and equipage in general, and almost to an endless variety of valuable purposes, and in particular to carriages; and also a method or methods of making less disastrous and less frequent the overturning of carriages, and of improving their structure and of guiding and governing the same, which carriages or mechanism, when embracing his appendages and conceits, he distinguishes by the name of Oss or George's Wain. Dated February 4, 1808. Specification to be enrolled within six months.

SAMUEL BROWN, a Lieutenant in the Royal Navy, and now residing in Castle-court, Budge-row, Watling-street, in the City of London, for certain inventions and improvements in the rigging of ships or vessels. Dated February 4, 1808. Specification to be enrolled within six months.

WILLIAM FRANCIS SNOWDEN, of Oxford-street, in the county of Middlesex, Engine-maker, for certain improvements in an engine for cutting hay and straw into chaff, and for cutting other articles. Dated February 4, 1808.

JOHN SHORTER MORRIS, of Pancras-place, in the county of Middlesex, Gent. for a certain machine for mangling. Dated February 4, 1808. Specification to be enrolled within four months.

RALPH WEDGWOOD, of Oxford-street, in the county of Middlesex, Gent. for his apparatus for producing several original writings or drawings at one and the same time, which he calls a pennapolygraph, or pen and stylographic manifold writer. Dated February 22, 1808. Specification to be enrolled within one month.

THE

REPERTORY

OF

ARTS, MANUFACTURES,

AND

AGRICULTURE.

No. LXXII. SECOND SERIES. May 1808.

Specification of the Patent granted to EDWARD THOMASON, *of Birmingham, in the County of Warwick, Manufacturer; for an improved Mode of making Hearth-Brushes.*

Dated October 31, 1803.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with and agreeable to the true intent and meaning of the said proviso in the said letters patent contained, I the said Edward Thomason do hereby declare, that the following is a particular description of the nature of my said invention, and methods and improvements in the mechanism of hearth brushes, both in respect to principle and the way and means in which the same may be performed; that is to say: with respect to principle, I cause the bristles to be hid or concealed in the case, tube, or stail, of which I call the "non constat" hearth brush, by the action or movement of pulling towards you the stail, tube, or case, or pushing from you the stail, tube, or case, or

each or any of them, as circumstances may require; and I cause the bristles to be ejected or thrown out into a convenient posture of the said case, tube, or stail, by the aforesaid action or movement; that is to say: by pushing from you or pulling towards you the stail, tube, or case, or each or any of them, as circumstances may require. Now I do declare the above-mentioned principle comprehends the real object of my invention; and in order for the better comprehension and understanding how the aforesaid may be reduced to practical use, I do hereby further declare, that although I vary the mode of construction by a variation of circumstances to produce the said effects, and obtain the main purpose intended, that is to say, of concealing the bristles from the eye when the brush is not being used: yet I principally adhere to the method herewith described, as being fully answerable to what is required, and best calculated to be understood from the drawings and descriptions thereof; and the same is described in the three drawings and nine sections represented in the margin of these presents, and the alphabetical letters in the nine sections refer to their respective parts in the drawings.

Drawing Fig. 1, (Plate XV.) represents the hearth-brush in a quiescent state, or after it has been used and shut up, the bristles being concealed in the case X.

Drawing Fig. 2, represents the hearth-brush ready for use, the bristles being ejected or thrown out of the case X by the movement of the tube A, and the stail of the brush lengthened,

Section No. 1, is the outward tube, and slides upon section No. 2, which is an inner tube.

Section No. 2 at F, is screwed or attached to the brush-case, section No. 6, at P.

Sections

Sections Nos. 3, 4, and 5 are two racks and a cog-wheel, all of which work or move together within the inner tube, section No. 2, as represented in section No. 8; that is to say: the cog-wheel section No. 4 is fixed by a pin in the inner tube, section No. 2, and moves on two centres at E E in section No. 2.

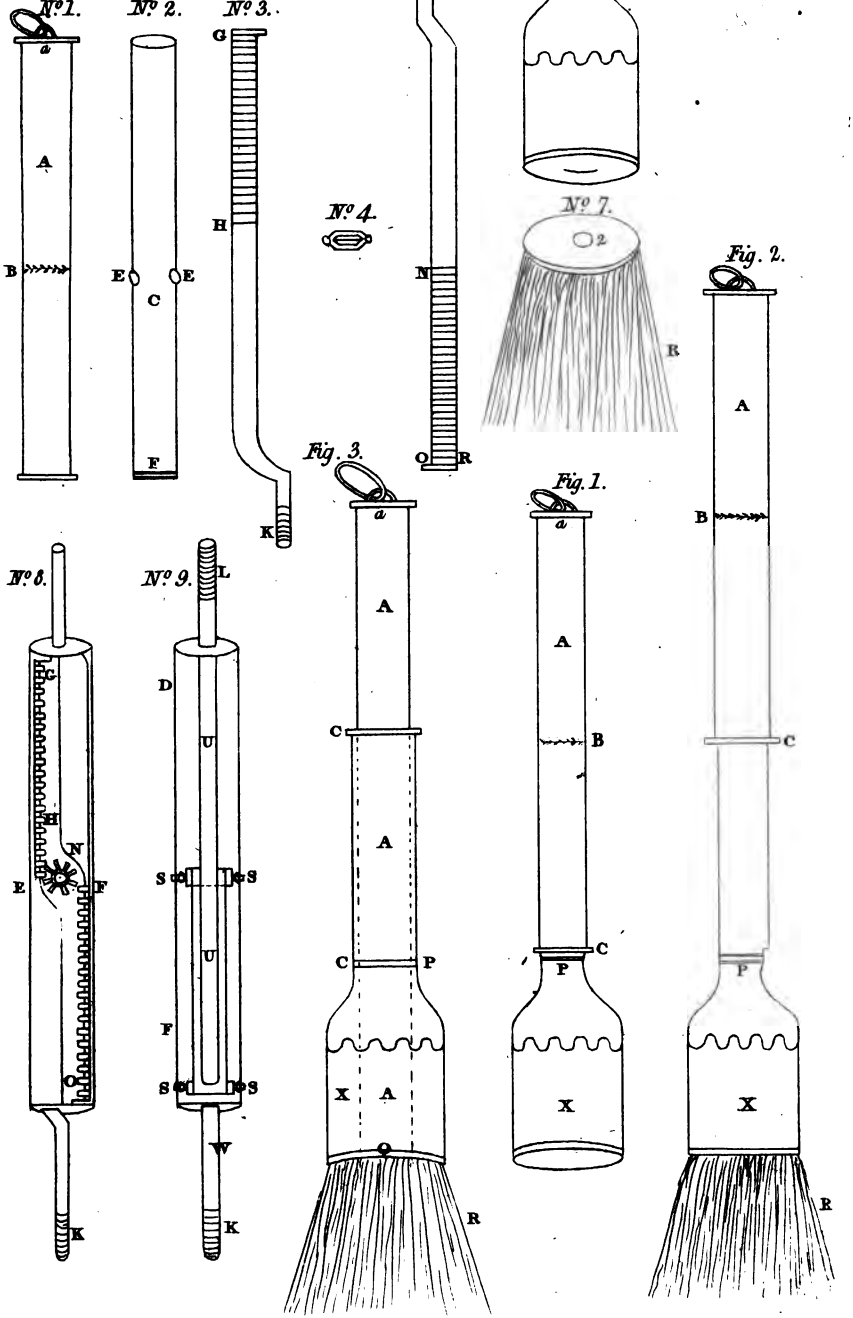
Section No. 3, is a rack, to which the brush No. 7 is attached at K, and moves from G to H on the cog-wheel, section No. 4. Section No. 5 is another rack, which moves from N to O on the cog-wheel, section No. 4, and the end L is fastened to the end of the handle tube, section No. 1 as at *a*. It is evident then, when the cog-wheel is fixed in the inner tube, section No. 2, and the two racks properly placed as in section No. 8; that by pulling the end of the rack L, it will give action to the cog-wheel, section No. 4, which cog-wheel in moving gives action to the other rack, section No. 3, and if the rack and cog-wheel are truly made, the rack, section No. 3, will recede from you just as much as the other rack, section No. 5, will move towards you. It is by these means that the stail of the brush is lengthened, and the bristles forced out of the case, section No. 6, into a convenient situation for use.

Section No. 9, is another manner of making the internal movements to obtain the same motion and answer the same end; that is to say: that instead of racks and cog-wheels, as in section No. 8, I use two or a greater or less number of rollers, drums, or pullies, which move upon their centres at S S S S: a band made of leather, or any other substance that will answer the purpose, is put round these rollers, and sewed or fastened at its two ends as light as convenient. The leg or shaft L U U is

fastened to one side of the band, and the leg W to the other side of the band; the leg or shaft L U U within becomes the acting leg, or that which is joined to the handle *a*, as at section No. 1, in the same manner as section No. 5 is attached to the handle *a*; and the leg W becomes the brush leg to be attached to the brush part section No. 7, as in manner represented by section No. 3. It appears evident then that if the leg L is pulled, the band will move round upon the rollers in a space nearly as great as the distance from one roller to another, consequently the leg L will have moved out of the tube D F the like space; and on the contrary, the leg W and K will recede or eject from the other end of the tube nearly the same distance.

Drawing Fig. 3 shews how the brush may be hid or concealed in the case, tube, or stail X, by a more simple and less expensive method; that is to say: the tube A A A, is small enough to slide within the tube C C, and long enough to reach the roof or upper part of the brush, and attached thereto as at Q; consequently, if you lay hold of the tube A A A, at *a*, and pull it upwards or towards you, the bristle or brush part, being attached to it, must necessarily slide into the case X, and by returning the tube A A A into the tube C C, it will naturally force the bristles out of the case X, as is exemplified in the Drawing Fig. 3: and I do hereby further declare, that these hearth-brushes may be made of any kind of metal, such as iron, steel, copper, brass, or any other metal or composition of metal, or any kind of wood, bones, ivory, paper, or any other substance or composition of substances, that may be found sufficiently strong and proper for the purpose or purposes of manufacturing the hearth-brushes. In witness whereof, &c.

Specification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Specification of the Patent granted to SAMUEL SALTER, *of Watford, in the County of Herts, Maltster; for an Apparatus for the Purpose of drying Malt, Hops, or any Kind of Grain.* Dated December 19, 1807.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Samuel Salter do hereby declare that my said invention is described in the manner following; that is to say: The entrance of the kiln-hole or fire-place is inclosed with a cast or wrought-iron frame, or in any other way, or with any other suitable article that the heat of the inclosed fire will not destroy. In the frame two doors are fixed, one at or near the top, the other at or near the bottom, of sufficient dimensions to admit the supply of fuel for the fire, and also for taking out the cinders and ashes beneath the fire. In the upper door is an aperture, of proper size to admit the necessary quantity of air to carry off the steam that may arise from the malt, hops, or any kind of grain intended to be dried: the size of the aperture must depend on the nature and construction of the kiln; and as in the different stages of drying any of the articles before specified, it is requisite to vary the quantity of air admitted, a slide or regulator is affixed to the door for that purpose. In the lower door is also an aperture, which may be of the same size as in the upper one, with a slide or regulator to admit more or less air as the state of the fire may require. The bars on which the fire is placed or kept are either of cast or wrought-iron, and are placed at the distance

distance of about half an inch from each other, in order not only to make the fire burn freely, but that a considerable quantity of air may pass through the fire; and being rarified thereby, will greatly assist both in drying the articles before specified and carrying off the steam also; the number and length of the bars must be governed by the size of the kiln.

The sides of the kiln-hole or fire-place are cast-iron, or any other article or thing that the fire will not easily destroy; if of cast-iron about half an inch thick will answer the purpose, and in that part on each side against which the fire lies is a piece of cast or wrought-iron, or any other article or material that will hold the heat, of about eighteen inches long, about six inches deep, and about two inches thick, to project into the fire-place, which not only prevents the sides from being destroyed by the fire; but being kept red-hot, thereby necessarily throws a great heat into the body of the kiln. The upper edge of the projecting piece may be bevelled off, to prevent the coals or fuel resting on it, and thereby damaging the sides. The top of each of the sides forms the base of an arch of cast-iron, or any other material that will answer the purpose, of about the same thickness of the sides. The ash-hole beneath the fire should be about eighteen inches long, twelve inches wide, and twelve inches deep.

In witness whereof, &c.

Specification

Specification of the Patent granted to ROBERT BARLOW, *of Spring Gardens, in the Parish of St. Martin in the Fields, in the Liberty of Westminster, and County of Middlesex, Chemist and Medical Electrician; for certain oriental, aromatic, chemical Compositions or Compounds, to be made up and moulded into various Forms, Shapes, and ornamental Devices, as Amulets in Butterflies, Birds, Shells, and Animals, and to be worn as an ornamental Part of Dress by Ladies and Gentlemen as Rings, Broaches, Lockets, Pins, Combs, Bandeaus, and other Ornaments; and for various other useful Purposes; which oriental, aromatic, chemical Compositions he denominates "Ebenbosamic and Ebengavui bosamic Compositions or Compounds," or aromatic variegated artificial Marbles and Stones, opaque and transparent.*

Dated June 16, 1807.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Robert Barlow do hereby declare, that my said invention is described in manner following; that is to say: Take of various aromatic herbs agreeable to the scent required, one pound well dried by the solar rays, beat the same in a mortar to a powder, and put them in a wide-mouthed jar or bottle made of glass, and as much of the best alcohol or high-rectified spirits of wine as will cover or rise above the surface when pressed down six inches; then place such jar or bottle in the rays of the sun for six or seven days, more or less as may be required, then draw off the same by distillation; when this aromatic spirit is fully prepared, there must be dissolved therein

therein such aromatic gums as may be thought necessary to select, of each one ounce; when the mucilage is ready, mix with the same of rose-wood powder, of Turkey rose-leaves, and oriss-root, until it becomes the consistency of paste; then add to the composition, being in weight one pound, the following essentials: otto of roses three drachms, oil of cloves four drachms, best grain musk four drachms, frankincense and myrrh each two drachms, and oil of sweet nuts one ounce, these essentials being previously well ground in a marble mortar; after which, add such colours from fruits, flowers, &c. as saffron, cochineal, saunders, safflower, &c. as fancy shall dictate; then to be formed into any required shapes or forms, in moulds prepared for that purpose in the usual way. In witness whereof, &c.

Observations by the Patentee.

The above described chemical composition, which I have denominated *Ebengavui bosamic* paste, in its appearance imitates all kinds of variegated marbles, stones, Egyptian, Scotch, and other pebbles, and displays their most wonderful and beautiful colours and veins; the most scrutinizing eye being scarcely able to discover whether they are natural productions finished by art, or an artificial composition. The various elegant shapes into which the composition is capable of being formed as ornamental trinkets for dress are innumerable, and the delectable fragrance which they possess is not to be destroyed, and is communicated to every thing near to which they are placed.

The Patentee conceives it to be proper on this opportunity to guard the public against a spurious and deleterious article that has been brought forward by certain indi-

individuals, in imitation of the above described composition made up of pipe-clay, lamp-black, gum, vermillion, verditer blue, &c. The two latter substances being most pernicious and poisonous drugs, the first being made of mercury or quicksilver, and sulphur or brimstone; and the latter of the oxyd or verdegris of copper, and sal-ammoniac, which composition when applied to the oolfactory nerves, not only injures them but is destructive to health of persons wearing it.

Specification of the Patent granted to WILLIAM WELLER, *of Cavendish Street, Cavendish Square, in the County of Middlesex, Gentleman; for a Method of manufacturing, forming, making, and engraving, Copper Plates for printing Policies, to secure Persons from Loss of Property of certain Descriptions.* Dated June 17, 1800.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said William Weller do hereby declare, that my said invention of manufacturing, forming, making, and engraving, copper-plates for printing policies to secure persons from loss of property of certain descriptions, is described in manner following; that is to say: The plates are to be manufactured out of sheet copper, and made of folio size, in a rectangular or parallelogram form, properly prepared and highly polished for engraving, which is to be executed in a neat, elegant, and masterly like manner. At the top of the plate or policy (in the centre) will be neatly engraved his majesty's arms, with this motto "By his majesty's royal letters patent;" on one side of the plate or policy parallel with his majesty's arms will be neatly engraved the figure of

Justice, round or under which will be this motto "Property secured." On the other side of the plate or policy parallel with the other figures will be neatly engraved the bust or head of the patentee, round or under which will be this motto, "William Weller, inventor." On one side of the plate or policy will be neatly engraved or cut a curious scroll or check the whole length of the plate, down which will be engraved this motto "Property secured from thieves and robbers," part of which when the policy is cut out will go with the policy to the insured, and the counterpart remain in the book at the office by way of check. The body of the policy will be neatly engraved, and contain as far as possible so much of the covenant and necessary matter as appertains thereto, and is fair and equitable between man and man, or the insurers and insured, with proper blank lines left to be filled up (with the pen) with the different sort and species of property insured, specifically particularised and minutely described. These engraved copper-plates, forming together the most grand and useful policy of security ever yet made in this kingdom, are for printing patent policies to insure and secure persons from loss of property of certain descriptions as hereinafter particularized. The great public utility of these plates or policies is (with the patronage of the public) to secure and insure his majesty's subjects from the loss of a sort and species of property at present entirely unsecure and unprotected, though daily exposed to great danger, as may be seen by the frequent losses sustained, and the numerous depredations daily committed in this metropolis, its environs and the kingdom at large. Insurances in general have been found and proved very useful to the community, and numerous offices

offices have been opened for the above purposes, but nothing has ever yet gone (till this) to secure and insure a certain sort and species of property exposed to great danger by thieves and robbers, neither has any other kind or species of property been ever yet protected, secured, and insured, by engraved copper-plate patent policies. The effecting this great and most desirable object appears to have been reserved for the patentee; who by great labour and expence is the whole and sole inventor and founder of this grand and long-wished for design; and for which his majesty has been most graciously pleased to grant his royal letters patent to William Weller, for making copper-plate engraved policies, to secure his majesty's subjects from loss of property of certain descriptions of which the following are the particulars.

First. These patent policies go to secure, insure, and indemnify persons from loss of property by burglaries and all forcible entries, whether by day or night, in their dwelling-houses, out-houses, warehouses, shops, and other premises, agreeable to the policy and the conditions of insurance thereunto annexed.

Second. These patent policies secure, insure, and indemnify persons (such as merchants, shop-keepers, tradesmen, and others,) from loss of any merchandizes, wares, stock in trade, &c. by burglaries out of any house, warehouse, and other premises, insured by these policies, agreeably to the policy, and the conditions of the insurance thereunto annexed.

Third. To secure, insure, and indemnify persons from loss of property by highway and footpad robberies, agreeably to the policy, and the conditions of insurance thereunto annexed.

Fourth. To secure, insure, and indemnify persons from loss of property by horse-stealing, agreeably to the policy and the conditions of insurance thereunto annexed.

Fifth. To secure, insure, and indemnify persons from loss of property, by having their beasts or cattle stolen, and have their loss made good agreeably to the policy, and the conditions of insurance thereunto annexed.

Sixth. To secure, insure, and indemnify persons from loss of property, by having their sheep stolen, and their loss made good, agreeably to the policy, and the conditions of insurance thereunto annexed.

Seventh. By these patent policies persons may insure their property from private thefts, and have their loss made good upon conviction of the offender or offenders (and not otherwise), agreeably to the policy, and the conditions of insurance thereunto annexed.

Eighth. By these patent policies persons may insure against consolidated risks, and be secured, insured, and indemnified, from loss of property, by burglaries and fire, whether by day or night, in their dwelling-houses, out-houses, warehouses, shops, and other premises, and will have their loss made good agreeably to the policy, and the conditions of insurance thereunto annexed.

Ninth. By these engraved copper-plate policies persons may secure and insure any other sort or species of property or merchandize, upon the high seas, or elsewhere, and will have their loss made good agreeably to the policy, and the conditions of insurance thereunto annexed.

The

The great public utility of these patent policies are to protect, secure, and insure, his majesty's subjects from loss of property, the greatest part of which is at present quite unprotected and unsecure, though daily exposed to great danger: with the hopes of removing the evil, or at least checking and suppressing those alarming depredators (namely) thieves and robbers, who so numerously infest this metropolis, its environs, and the kingdom at large. To effect this great and desirable end Mr. Weller intends (if patronized by the nobility, gentry, and the public,) establishing a general insurance office (to be conducted by the patentee,) to insure and secure by these patent policies his majesty's subjects from loss of property hereinbefore described and specified, which it is trusted will be found of great public utility, as the following advantages will most evidently result therefrom.

I. An indemnification from loss of property at present unprotected by any insurance.

II. The assistance of the office in detecting and bringing offenders to justice.

III. A gratuity to the widow, child, or children, upon the husband or father being killed in defending any property insured (by these patent policies) in case of attack.

IV. A constant reward of five guineas over and above the usual rewards (upon conviction) to any watchman, patrol, or to any other person or persons who shall take into custody any one or more, who may have robbed, or shall attempt to rob any one insured by these patent policies, which will be easily discovered by the office mark, or plate to be affixed upon some conspicuous part of the outside of the house, premises, or building, so inscribed,

inscribed, by which it may be readily perceived that the houses and property of persons insured will be more secured than those who are not so.

V. All patent policies are stamped according and agreeably to act of parliament, by which it is humbly conceived the policies must be of great public utility as they will tend to secure the property of the subject, aid the police of the country, and increase the revenue thereof. In witness whereof, &c.

Specification of the Patent granted to GEORGE HAWKS, *of Gateshead, in the County of Durham, Iron-Manufacturer; for a Method of making and likewise keeping in Repair Cast-Iron Wheels for Coal Waggons and other Carriages, where such Wheels are applicable.*

Dated Nov. 6, 1807.

With an Engraving.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said George Hawks do hereby declare, that my said invention is described as follows; that is to say: The usual method of making iron wheels for coal-waggons, and other carriages where such wheels are applicable, is to cast their arms and rims in one entire piece, by which method they are partially weakened by the irregular contracting of the arms and rims in cooling, and are consequently subject to be frequently broken from trifling shocks or jerks; and when the rims are worn out or broken, or when any other part of the wheel is injured, the whole wheel becomes useless, and must be replaced

replaced by an entire new one; these defects are removed by my invention, which consists simply in making or casting the wheel in two or more parts, and in joining those parts together by screws, rivets, pins, forelocks, keys, dovetails, rabbits, or mortises, as is frequently done with wheels used in the machinery of mills and similar purposes, or by any other convenient means; by this method the injuries occasioned by the contraction of the metal are avoided, the wheel is much stronger with the same weight of metal, and in the end prodigiously less expensive than those cast in the common way of one piece; for when partially injured by wear or accident, they can be repaired with little expense, whilst those on the old plan must be replaced by new ones on every accident; in the old method the manufacturer is compelled to select the softest iron for his purpose, not only for the sake of avoiding the accidents alluded to, but also of preventing that of an entire fracture in cooling; a soft material operates against the durability of the wheel, and is by my method not only not requisite, but I am enabled to select such metal as is best suited to the purpose of durability, and to replace worn out or broken rims with new ones, to the old uninjured arms or new arms to serviceable rims; thus I venture to assert, that wheels made according to this method will combine strength, durability, and economy. The accompanying drawing (Fig. 1, Plate XVI.) represents a wheel calculated for the general class of Newcastle coal-waggons; but of course the strength, diameter, and description of the wheel, with other material points, depend upon the carriage to which the wheel is to be fixed, and the road on which it is to travel.

In witness whereof, &c.

Description

Description of a Fire Alarm.

Invented by Mr. JAMES PHŒNIX, *of Liverpool.*

Communicated by him in a Letter to the Editors.

With an Engraving.

GENTLEMEN,

A, Fig. 2, (Plate XVI.) represents a glass vessel, calculated to hold about three pints of water; but in winter it may be half filled with spirits, as water alone would be liable to freeze. First, fill it with water up to the shaded part B, then suspend it over a tube similar to a spout, with a small piece of loaf-sugar, say half an inch square, at the farthest end as at *c*, which will prevent the spring D from escaping; this spring communicates with an alarm, or rings the bell in the lobby. Supposing the room on fire the heated air will ascend rapidly, causing an expansion of the air in A, which will force the water over on the sugar and dissolve it, and thereby allow the spring to escape and give the alarm, sufficiently before the house would be dangerously on fire.

E, the wire communicating with the alarm or bells.

F, the supposed room of the house.

G, the gutter for the water to run down.

One of these alarums would be requisite for each room of the house.

I am, Gentlemen,

Yours, &c.

JAMES PHŒNIX.

Description

Figs. 1.

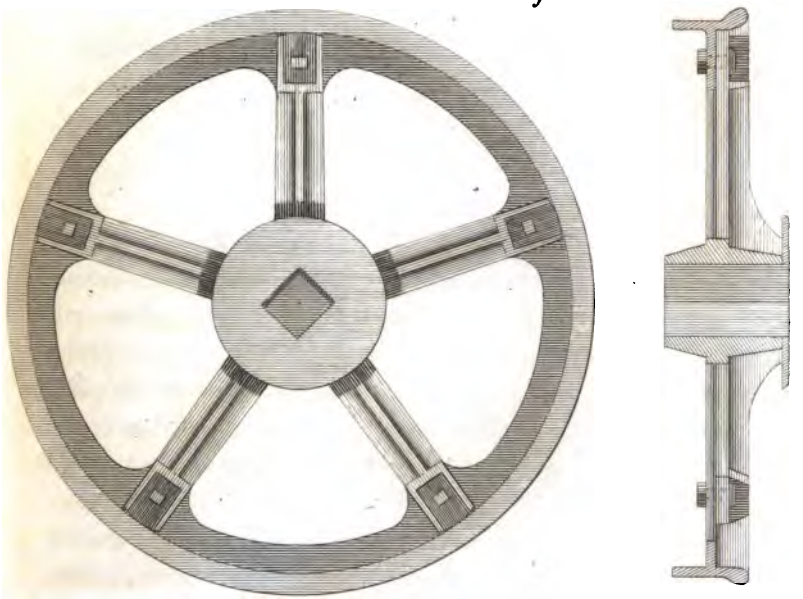
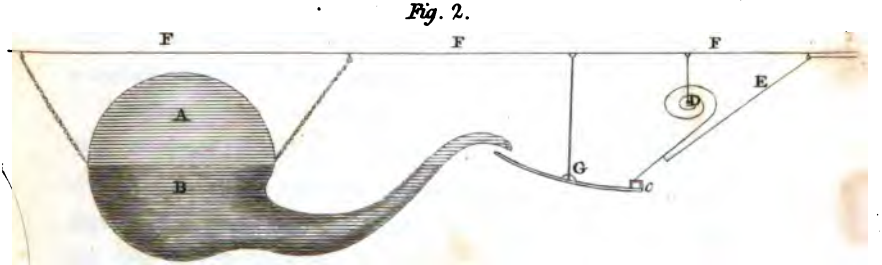


Fig. 2.



Description of a Double-lever Press for various Purposes, particularly applicable to the pressing Water out of Cloaths, commonly done by wringing. By Mr. J. L. HAWKINS, *of Titchfield-Street.*

Communicated in a Letter to the Editors.

With a Plate.

GENTLEMEN,

YOUR valuable work being professedly devoted to promote the knowledge, and improve the practice of the useful arts, I am induced to present you with descriptions of the articles in my Useful and Mechanical Museum which is just opened, feeling that I ought to describe them myself, lest imperfect or false accounts obtain circulation.

The principal object of the establishment is to give publicity to, and encourage the general adoption of, several improvements which have occurred to me from time to time for many years past; and I flatter myself, it will possess sufficient attractions to bring me the means of keeping it open, and extending it without loss.

Although my inventions constitute the leading feature of the exhibition, yet it is not confined exclusively to these; for the inventions and improvements of other persons are and will be introduced, as occasions afford them; as well as experiments instituted, to solve a number of difficult mechanical problems.

To give your readers an idea of the complexion of this Museum, it will be well to insert the list of improvements that first appeared in my Proposals in November last, more than half of which are now exhibiting, and the rest in preparation.

List of Improvements to be placed in Hawkins's Useful and Mechanical Museum.

1. Model of a Planetarium, to occupy some acres of ground, intended as a magnificent ornament to a park, and calculated to raise sublime ideas of the heavenly bodies.

2. Model of a Bridge with one arch, capable of being thrown over the Thames at London.

3. Plan for a City, uniting health, convenience, and beauty.

4. Model of a Fire-escape, easily applied to a house from the street.

5. Book-shelves, so constructed, that in case of fire, a large library might be removed in a few minutes, without injuring a book.

6. Improved Fire-places, to save coals and carry smoke well.

7. An improved vessel for Cooking by steam.

8. A portable Oven and Ironing-stove, to be used over a common fire.

9. A Candlestick, to fit any sized candle.

10. A cheap and simple self-acting Extinguisher.

11. A cheap Spring to shut a door.

12. A simple and cheap Apparatus, easily attached to a Door, to make it shut close at bottom, and yet rise over a carpet.

13. A Door to open four ways, the hinges being instantly changed from one side to the other.

14. A Cock, by which a servant can draw no more liquor than he is ordered to do.

15. A useful Press, by levers, for various purposes, particularly pressing water out of cloaths, commonly done by wringing.

16. An

16. An improved Washing-machine.

17. A cheap Apparatus for filtering and purifying water.

18. An improved Lever for drawing water from wells.

19. A rotative Pump.

20. A Pump to work with much less friction than any in use.

21. Model of a Tide-mill, upon a new plan.

22. Methods of producing a rotary from an alternate rectilinear motion.

23. Communications of Motion in mill-work, without wheels.

24. A plan of winding up a weight, while it is acting on machinery.

25. Modes of accumulating small forces for various agricultural, domestic, and other useful purposes.

26. Model of a contrivance for obtaining great power at the sea-side, for working Mills, &c.

27. A Machine to be towed across a river, which will at the same moment draw on paper, to any reduced scale, the exact shape of the bottom; shewing at one view the depth of water in every part, together with the width of the river.

28. Plans for the Sails of large ships, to make them go nearer the wind, and a machine to prove their superiority over those in common use.

29. A simple way of finding the proper shape of the mould-board of a plough.

30. An easy method of strengthening a shaft in mill-work.

31. The Claviole, or Finger-keyed Viol, a new musical instrument, with 68 gut-strings, which will never

go out of tune, played in the same manner and producing all the brilliancy of the piano-forte and grandeur of the organ, and is in effect, a band of violins, tenors, violoncellos, and double bass.

32. A Violin, to fold up for the pocket.

33. A new mode of printing Music with types, and a model of a printing Press for the purpose; applicable also to various kinds of mathematical and ornamental printing.

34. Model of an apparatus for drying newspapers and other printed sheets, without loss of time.

35. A Bookbinder's Press, on a new construction.

36. A pair of Mathematical Compasses, particularly useful.

37. Simple modes of describing Ellipses, by means always at hand.

38. A machine for modelling and reducing Statues and Busts.

39. A mathematical instrument for measuring distances at one station.

40. A new plan of mounting Globes.

41. Methods of describing the Profile Outline of the Face, in words and numbers, so as to be written in a letter.

42. An instrument to engrave the facsimile of a letter on copper, at the same time it is written.

43. A floating Time-keeper.

44. A Galvanic Pile, on a new construction.

45. A simple Condenser for a small still, applicable to chemical purposes.

46. A contrivance to rock a Cradle.

47. Grammatical Tables, &c. very much facilitating the acquirement of several Languages.

48. An

48. An elastic Saddle, particularly easy for man and horse.

49. Artificial Ears, to assist the deaf, which can be constantly worn out of sight without inconvenience.

In addition to these, and for the accommodation of the Subscribers, there will be placed in the Museum, one of each of the Inventions for which I have obtained Patents, that are already before the public, *viz.*

50. A Patent Piano-Forte, with spiral strings and metallic frames.

51. A Patent Polygraph, or machine for writing two or more letters at the same time.

52. A Patent Scotograph, or instrument for writing in the dark.

53. A Patent Likeness machine, the only one hitherto invented by which the features of the face can be accurately delineated.

In selecting the articles for publication, a different order from the above will be adopted, for the sake of first describing those most easily to be brought into use, and such as established manufacturers can immediately make. The one chosen to commence with, is that numbered 15 in the list. It is brought forward with a view to restore to use a vast number of washing machines that have been laid aside within these few years, many of which answer their intended purpose very well, and do not injure the linen half as much as hand washing: I shall however shortly present the public with a very considerable improvement on them.

The chief cause of the disuse of washing machines has been, the want of wringing machines as companions to them; for it being necessary to wring a considerable quantity

quantity of cloaths together, immediately after their being washed in the machine, the labour is so severe on the wrists, that few women are able to perform it; but in the common way, while they are washing a second piece, the wrists are recovering themselves, from the strain they suffered in the act of wringing the first.

Many have attempted to make wringing machines, but have for the most part failed of success, by reason of their acting on the principle of twisting and stretching, which must unavoidably damage the cloaths.

In contriving a machine for this purpose, I soon determined on putting the cloaths into a bag, and that bag into a cylindric tub, having holes in the sides and bottom, and pressing the water out with a piston forced down on the bag, because that could not injure the most delicate texture; but several objections bore against giving this pressure with a screw, such as the great waste of power in overcoming its friction, particularly if made of wood, the time required to turn the screw back again after having performed its work: the difficulty of disengaging the pressing board or piston, so as easily to get at the cloaths, with other objections of less consequence. Several other well-known modes of applying force were also examined and found deficient in many points; at length the idea occurred, of having two levers acting in racks on a piston rod, alternately relieving each other.

I first carried this idea into effect in the year 1801, and made a complete machine for pressing the water out of cloaths, which answered the purpose so well, that they would dry in half the time required when wrung by hand, and the finest fabrics were not in the least degree injured.

Fig. 1,

Fig. 1, (Plate XVII.) is a perspective view of this machine, with the levers disengaged from the racks, and supported in convenient situations for allowing the piston to be easily taken out.

Fig. 2, longitudinal section of the machine at the side of one of the racks, with a view of the rack and piston rod, the lever being in its place in the rack.

Fig. 3, Plan on a larger scale of the top bar, with the end of the piston rod and racks.

Fig. 4, Transverse section, on a larger scale, of the levers, with part of the racks.

Fig. 5, Perspective view, on a large scale, of the hinge or fulcrum piece, together with a fragment of the lever.

The letters of reference are the same in all the figures.

a, two feet connected together by two rails *b*.

c, two uprights, carrying the top bar *d*, and strengthened by two braces *f*.

g the tub, supported on the rails *b*, having holes in it at *n*, and the lower corner filled up to keep the cloaths more compact, as shewn at *e*.

h the pressing board or piston, consisting of two pieces one upon the other, the grain of the wood crossing each other.

i the piston rod, sliding in a dove-tailed groove in the top rail.

k, a notch at the lower part of the dove-tail of the piston-rod, which when raised to the height of the top rail will allow the piston to be taken away.

l the racks.

m the levers, whose fulcra act in pieces *o*, that have rotation on a vertical axis *p*, passing through the top bar *d*, and kept up by the little pins *r*.

s, supports

s, supports for resting the levers on when not in use.

t a plate of iron let into the top bar, for the pieces *o* to go through; there is a similar plate at the under-side of the bar.

The racks, levers, and fulcrum pieces, are made of cast-iron; but the levers are elongated with wooden handles; the two racks are in one piece, put through a mortise in the piston-rod, and fastened there by rivets *u*; a thin canvas bag is made to fit the tub, but about twice the length; the rest of the machine is of wood.

A tub of eight inches diameter, and eight inches deep, inside measure, will take from six to eight shirts, or from two to three sheets at once; but should it be wished to operate on a greater quantity at the same time, I would recommend the tub to be increased in depth rather than width, for if the diameter be enlarged, the levers must be lengthened to an inconvenient degree, or a deficiency of power suffered; the water also would have to force its way through a greater body of the cloaths, in passing from the centre laterally.

The size of the frame is not very material. I have made it thirty inches high, standing on a base of thirty-six inches by fifteen, the rails, uprights, and feet, are three inches square. The length of the lever is thirty inches, and the rack two inches from the fulcrum, giving a power of fifteen to one, working almost without friction.

To use this machine.—Place the levers on their supports, and take out the piston, put the clothes into the bag, and the bag into the tub, twisting the mouth together, and put in the piston.

Apply one of the levers to the rack, and press it down; apply the other lever to its rack, and press down also; then

then raise the first lever to a higher tooth of the rack, and proceed in the same manner, till the piston will descend no lower: let the levers remain a short time in the racks, that the water may drain off.

To release the piston; hold down one of the levers, while the other is put into a lower tooth of the rack, then take out the first lever, and let the piston rise; proceed in this manner till both levers can be disengaged, the piston may then be taken out, and the cloaths will be found drier than any hand-wringing can make them.

The machine may be used over a sink, or set in a shallow tub made for the purpose.

Since short and descriptive names save much circumlocution in conversation, and assist in the speedy communication of ideas, and since it is proper to distinguish this from the screw press, &c. I shall call it the double-lever press; but as it is applicable to a variety of purposes, it will be necessary, besides this generic name, to give specific names, designating the particular purposes for which the presses are made; on that ground the press above described, being for the use of the laundry, will bear the name of the laundry press; and when it is wished to express its construction as well as use, the double-lever laundry press will be proper.

The double-lever principle is applicable with peculiar advantage to many presses where a wooden screw is now used, but perhaps to none more than the cyder press; in which by far the greatest part of the force applied is wasted in overcoming the friction of the unwieldy wooden screws usually employed. For this and other presses requiring so much force, the lever must be made long, and the rack put very near the fulcrum; the force of a great weight may then be had at the end of the

lever, by which an immense pressure will be obtained; the rack, together with that part of lever which acts in it, must be of well-tempered steel.

Fig. 6 represents a good form for such a lever; where instead of the fulcrum turning on a pin, it acts against an edge *a*, on the scale beam principle; the teeth of the rack may be made obliquely, to throw the bearing of the lever nearer the fulcrum. The lever extends in breadth, below where it acts in the rack, for the sake of strength, as is shewn more clearly by the transverse section Fig. 7.

Fig. 8 is a horizontal section in the plane of the fulcrum.

In cases where an extremely great power is wanted, three levers may be used, as seen in Figs. 9 and 10, a large lever *a*, acting on the press *b*, and two smaller ones *c*, applied to the curved racks *d*, fixed on the end of the large lever. In this case, the large lever, instead of taking immediately into the main rack *f*, must be furnished with a spring-catch *g*, turning on a pivot at *h*, and guided so as to catch into the rack, when the lever is lifted up. There must also be a catch *i* attached to the main beam *k* of the press, to prevent the return of the pressing rod *b*.

The expense of presses on this construction will be less than any other of equal power and durability; and work may be performed by them in very much less time than by those already in use.

I am, Gentlemen,

Yours, &c.

JOHN I. HAWKINS.

Account

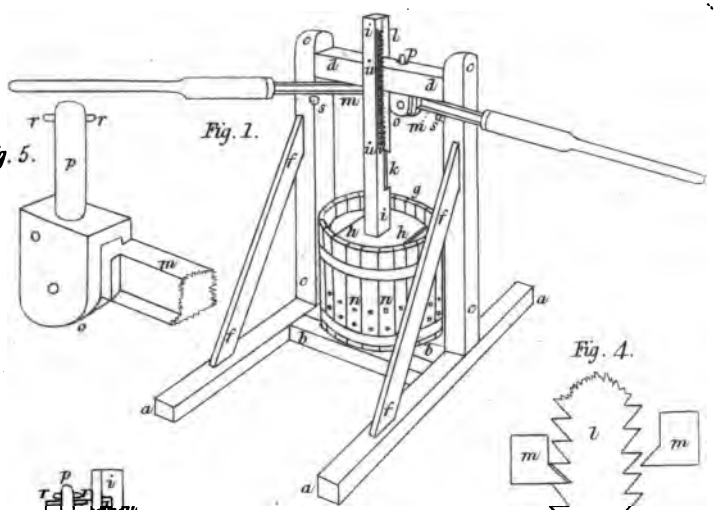


Fig. 1.

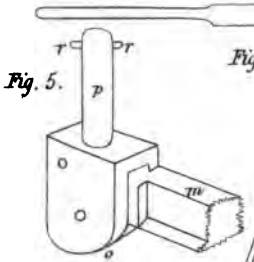


Fig. 5.

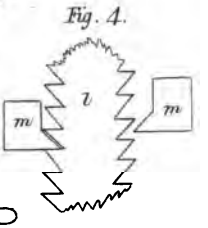


Fig. 4.

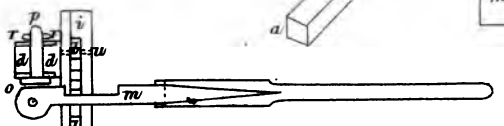


Fig. 2.

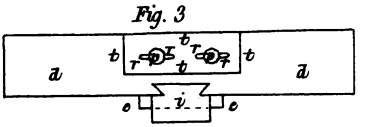
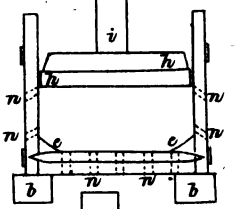


Fig. 3



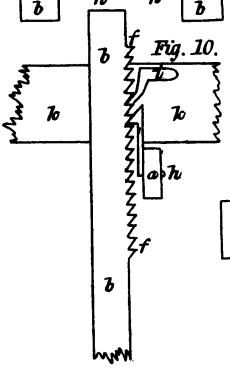


Fig. 10.

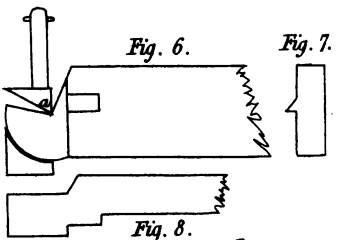


Fig. 6.

Fig. 7.

Fig. 8.

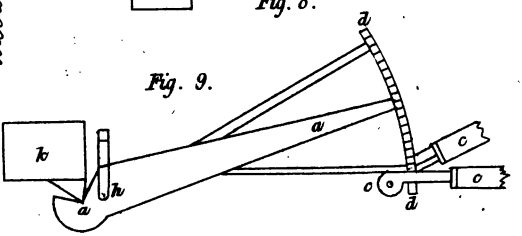


Fig. 9.

Account of the Improvement of a Moor near Tranent, East Lothian.

By Mr. ROBERT HAY, *at Standerts.*

From the PRIZE ESSAYS and TRANSACTIONS of the HIGHLAND SOCIETY of SCOTLAND.

THE condition of the moor which is the subject of this report, previous to 1799, was in an eminent degree unpromising. It was possessed by the former tenant and his forefathers, conjointly with the other tenants on the estate, for about fifty years, and they occupied the whole estate for forty years more.

Until within these last twenty years, the tenants on other two estates were entitled to carry fail and divot from this moor, for repairing their houses.

The moor in question never paid the possessor one shilling *per* acre; and in 1799 it was covered with whins, except a few spots which were overspread with heath. The soil is partly black moorish loam mixed with a white sand, and a hard bottom of small stones,—and partly a brown sandy soil, on a bottom of hard stone, insomuch that when the plough goes over it, the noise startles the horses. A part of the surface is very uneven, and the soil so shallow that it would not admit of being levelled with the plough; if it were so treated, the surface in some parts would have been peeled so bare, that it would have produced no crop. I therefore resolved to abstain from levelling any part of it; but I traced out the low ground, and drew cross furrows, which, being kept clean, laid the whole so dry, that no water stagnated on the surface.

I was advised to level the moor with the plough, but declined to comply with this advice for the reasons stated above; but I consented to level it with horses and carts, and to carry soil from a road forty feet broad cut through the said moor; this, however, was thought too expensive a mode of levelling it; the scheme was not of course carried into execution. The crop nevertheless was equally good over all the ground.

The moor now constitutes two inclosures, one containing twenty-seven acres, and the other ten acres, and will let on a lease of nineteen years for fifty pounds *per annum.*

Estimate of the Expenses incurred in bringing this Moor into Culture. It consisted of thirty-seven Scots Acres.

1799.						
March.	To 37 Scotch acres of whins hoeing, at 30s.	£.	55	18	0	
July.	To 37 acres of whins burning after hoeing, at 2s. - -		3	14	6	
Nov.	To 37 acres first ploughing, with two horses in the plough, at 12s. *per* acre - -		22	4	0	
		£.	81	8	0	
	To 3½ years interest on 81l. 8s. from Nov. 1799, to Whitsunday 1803, at *5 per cent.* -		14	6	0	
					£.	95 14 0
	Carry over				£.	95 14 0

1800.

1800.	Brought over				£.	95	14 0
July.	To 37 acres cross ploughing, being the second ploughing with two horses in the plough, at 10s. *per* acre	£.	18	10 0			
	To 2¼ years interest on 18l. 10s. from Martinmas 1800 to Whitsunday 1803, at 5 *per cent.*		2	6 3			
						20	16 3
1801.							
June.	To break-harrowing 37 acres, at 6s. *per* acre	£.	11	2 0			
	To gathering and leading off stones from 37 acres, at 3s. *per* acre		5	11 0			
July.	To 37 acres ploughing, being the third ploughing, and laid up in ridges 15 feet broad, at 10s. *per* acre -		18	10 0			
	To 37 acres once rolled (not harrowed) at 1s.		1	17 0			
Aug.	To 10 acres limed, at 60 bolls of shells *per* acre, Linlithgow barley measure — 600 bolls, at 20d. - -		50	0 0			
	To carriage of 600 bolls of shells, at 8d.		20	0 0			
	Carry over	£.	107	0 0	£.	116	10 3

To

1081.	Brought over	£. 107	0	0	£. 116	10	0
Aug.	To laying down the shells in small heaps on 10 acres, at 1s. *per* acre	0	10	0			
	To spreading the lime on 10 acres, when slacked by rain, at 1s. 6d. - -	0	15	0			
Sept.	To 10 acres ploughing, being the 4th ploughing, the ridges cleaved out, at 9s. - -	4	10	0			
	To 27 acres limed, at 70 bolls of shells *per* acre, Linlithgow barley measure—1890 bolls of shells at 20d. -	157	10	0			
	To carriage of 1890 bolls of shells, at 8d.	63	0	0			
	To laying down the shells in small heaps on 27 acres, at 1s. -	1	7	0			
	To spreading the lime, when slacked by rain, on 27 acres, at 1s. 6d.	2	0	6			
Oct.	To 27 acres ploughing, being the 4th ploughing, the ridges cleaved out, at 9s. *per* acre	12	7	6			
	To cleaning out the furrows - -	0	8	10			
	Carry over	£. 349	8	10	£. 116	10	0

To

1801.	Brought over			£.349	8	10	£.116	10	3
Oct.	To 1½ years interest on 349l. 8s. 10d. from Martinmas 1801, to Whitsunday 1803, at 5 *per* cent.			26	4	0	375	12	10
1802.									
March.	Inclosing 414 roods of a ditch, at 1s.	-	£.	20	14	0			
	20650 thorns, at 12s. *per* 1000	-		12	7	6			
	Pailing, 414 roods, at 2s. *per* rood	-		41	8	0			
	To 10 acres ploughed, being the fifth ploughing, the ridges cleaved out, at 8s.	-		4	0	0			
	To 48 bolls of oats, sown on the 37 acres, at 18s. *per* boll	-	-	43	4	0			
	To 37 acres harrowing, two double teams, at 3s. *per* acre	-		5	11	0			
	To 380 lib. red clover seed, at 11½d. *per* lib.			81	4	2			
	To 152 lib. white clover seed, at 15d. *per* lib.			9	10	0			
	To 152 lib. yellow clover seed, at 8d. *per* lib.			5	1	4			
	Carry over		£.	160	0	0	£.	492	3	1

To

1802.	Brought over	£.	160	0	0	£.	492	3 1
March.	To 19 bolls of rye grass seed, at 12s. *per* boll		11	8	0			
	To 37 acres harrowing in the grass seeds, one double team, at 1s. 6d. *per* acre - -		2	15	6			
	To cleaning out the furrows - -		0	10	0			
Sept.	To 37 acres of oats shearing at 10s. -		18	10	0			
	To 100 cart load of oats carriage from the field to the stack yard—3 miles, at 2s. -		10	0	0			
	To stacking and thatching ditto, &c. -		2	0	0			
		£.	205	3	6			
	To half years interest on £. 205 3s. 6d. from Martinmas 1802, to Whitsuuday 1803, at *5 per cent.* -		5	2	6			
							210	6 0
1803.								
April.	To gathering and leading off stones from 37 acres, and rolling, at 3s. *per* acre -		5	11	0			
	Carry over	£.	5	11	0	£.	702	9 1

To

	Brought over	£. 5	11	0.	£. 702	9	1
	To threshing 372 bolls of oats, and winnowing, at 5s. *per* hundred	13	15	6			
					19	6	6
July.	To 37 acres of hay mowing, making, ricking, and carrying to market at 14s. *per* acre	25	18	0			
					747	13	7

Cr.

1803.							
May.	By 372 bolls of oats at 14s. 6d. the produce of 744 threaves	£ 269	14	0			
	By 744 threaves of straw at 2s. 6d.	93	0	0			
	By 37 acres of hay, average 147½ stones *per* acre—say 37 acres at £. 7. 7s. 4d. *per* acre	272	11	4			
		635	5	4			
	This moor will now let for a lease of 19 years, at £. 50 *per annum*. Say 2¼ years rent more, will pay all the expence	112	8	3			
					£. 747	13	7

N. B. The oats and straw were all used in the farm—no expense for carriage.

Description of a Loom for making Fishing-nets; invented by Mr. JOHN ROBERTSON, *of St. Mary's Wind, Edinburgh.*

With a Plate.

From the TRANSACTIONS of the SOCIETY of ARTS, MANUFACTURES, and COMMERCE.

A Premium of Twenty Guineas was voted by the Society to Mr. ROBERTSON *for this Invention.*

A MACHINE for weaving nets has long been a desideratum in the arts. Fishermen experience many difficulties from their nets being frequently broken by dog-fish, and other marine animals, and the consequent length of time, required by the present mode of netting, in repairing their injured nets, or in making others. A fisherman is sometimes compelled, from such accidents, to relinquish fishing for a whole season. Any method, therefore, which leads to accelerate the fabrication of nets, without increasing the expense of them, must be beneficial to the community.

From this consideration, I have paid great attention to the subject, and now submit to the Society a model of a machine which, it is presumed, will answer the purpose held in view, of expediting net-work, while, so far from increasing the expense of them, it will diminish it.

I have, indeed, to regret, that from my obligation to provide, by my own manual labour, for a numerous family, I have been unable to establish the utility of the invention, by experience on an extensive scale. I am, nevertheless, convinced, that the invention is better adapted for the object in question, than any which has hitherto been proposed.

Reference

Reference to the Engraving of Mr. ROBERTSON'S *Loom for weaving Fishing-nets.*

Fig. 1 (Plate XVIII.) is the machine in a state ready to begin working, supported in a wooden frame. A is a beam, on which the twines for the net are rolled, in number equal to the knots tied, and from which they pass through circular tubes fixed in a bar B (shewn by dotted lines through the pulley, but seen better Fig. 2) which is fixed near the circumference of two equal pullies C, C, that turn on their axis by means of a cross-treadle, with small pullies at each end D, D, through which passes a band, one end of which is fastened on the frame at E, and the other on the pully C. At F, the band through the other pulley has one end fastened on the frame at G, and being wound round the farthest pulley C, is fastened on the under side of it, which by the alternate action of the treaddle on its axis H, moves the pullies C, C, and circular tubes from their situation in Fig. 1, to that in Fig. 3, and back again. In the centre of the pullies C, C, is fixed another bar P with a dove-tail groove, where the pirns that contain the twine are supported, (it being necessary to have two threads for every mesh, also one pirn more than there are tubes). In a groove under the dovetail is a slider L, moved by a wire K, fixed in each end of it, having pins in it, by which it moves the pirns backwards or forwards over the notches in the bar I, so as to cast a part of the knot: the pullies C, C, and bar B, move round the bar I as an axis, but independent of it, the bar I being fastened through the pullies to the frame. M is a moveable bar (centred within two supporters N, N, having two joints) with hooks, both for catching the twine at the end of the circular tubes, and

by crossing the hooks to the other side of the points of the tubes, to give the twine a turn for forming the knot, and by raising the points of the hooks, the ends of the tubes enter between them, as shewn Fig. 4: and by the circular motion of the bar B, when the two pullies C C, are turning on their centres by the foot, on the end, No. 1, of the cross-treaddle, and until the knots so formed are close to bar B, Fig. 3, (it is then what we call a running knot) a part of which falls into a notch cut below the level of the supporters of the pins in the bar I, then slide the pins over the notches that contain the twine, the knot is then cast, and then by the foot on the other end, No. 2, of the cross-treaddle, until the points of the tubes are returned to its former position, then remove the knot by disengaging the hooks and the tubes, then the knots are made tight as the wrought-part of the net is rolled on beam O, on one end of which there is a pulley P, with a band that communicates with the pulley, on the end of a short roller Q, in which are fixed four cross bits of wood that answer the purpose of treadles for the feet, by which it is drawn tight. R is another short roller communicating with the roller A, serving to give out the proper quantity of twine for the length of the meshes, or to hold it while the other roller tightens the knot. S is the seat.

Fig. 2. is a plan of the machine, the moveable bar and treadles left out to prevent confusion.

Fig. 3. is the situation of the running knot when the pirn goes through it.

Fig. 5. is the tube in the same position, shewing the manner the knot is twisted round it; and having the pirn and slider L taken out of the bar I, the dotted lines shewing at what height they come together. In

the

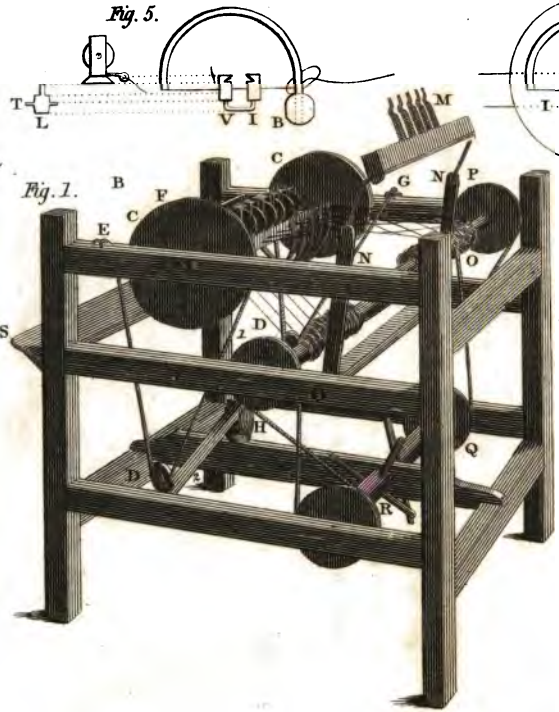


Fig. 1.
B
C
F
E
G
N
P
O
S
D
H
Q
R

Fig. 5.
T
L
V
I
B
M

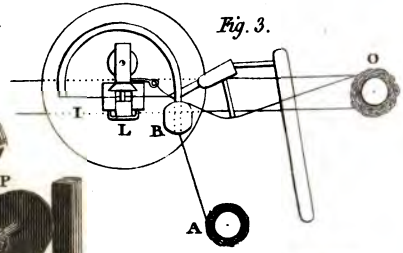


Fig. 3.
O
I
L
B
A

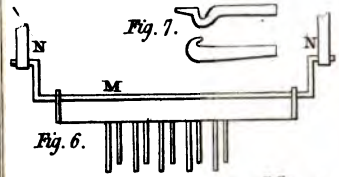


Fig. 7.
N
N
M
Fig. 6.

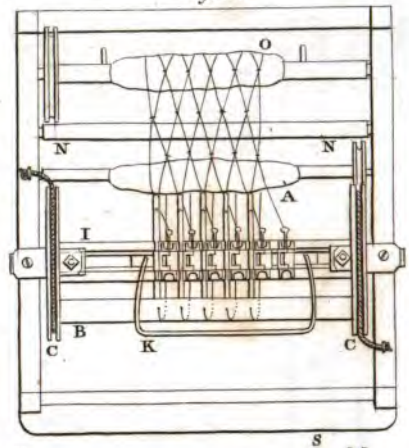


Fig. 2.
O
N
N
A
I
C
B
K
C
S

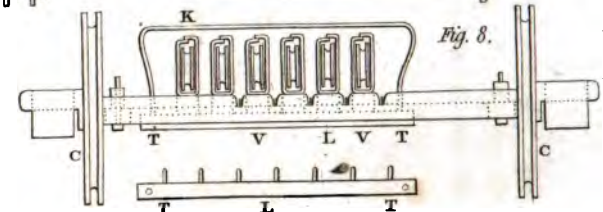

K
Fig. 8.
C
T
V
L
V
T
C
T
L
T
Fig. 9.

Fig. 4.

the slider L there are two pins, T T, to prevent its rising high enough to touch the string; and in the bar I there are two wires O O, like staples, to support the slider L in its place.

Fig. 6. is the moveable bar M with the hooks.

Fig. 7. is the hooks at large.

Fig. 8. is the bar I, shewing the notches in which the strings lay, to let the pirns pass over them, (when the tubes are brought over as in Fig. 3).

Fig. 9. is the slider L, with the pins that move the pirns.

Sir,

Mr. John Robertson, stocking weaver here, having lately communicated to the Highland Society of Scotland your letter to him of the 6th April, 1805, together with a model of his machine for weaving fishing-nets, I have been desired by the directors to recommend him to the notice of the Society of Arts, &c. and to mention that if his invention can be made practically useful, it will most materially contribute to the extension of the fisheries, by cheapening the expense of outfit.

Although improvements in the mechanic arts do not fall within the plan of their Institution, yet the Highland Society have given Mr. Robertson a few guineas, to enable him to attend personally on the Society of Arts, &c. and to explain his machine. I am, Sir,

Your most obedient Servant,

D. MACLACHLAN, Secretary.

Highland Society Hall, Edinburgh, March 26, 1806.

To C. TAYLOR, M. D.

From

From Mr. Robertson's subsequent statement to the Committee of the Society of Arts, &c. it appears that the nets used in the Northern fisheries are of one breadth throughout. He supposes he could make three courses of one hundred meshes each in one minute; that such a loom should be about 3½ feet wide, and would cost about fifteen or sixteen pounds.

A Certificate from Sir John Sinclair stated that Mr. Robertson's invention was much approved of in Scotland, and that he trusted it would be found entitled to the patronage of the Society of Arts, &c.

New Theory of the Tides.

By M. LAPLACE.

From HIST. DES MATHEMAT. *tome IV.*

M. LAPLACE has treated this subject in a very complete manner in the *Mem. de l'Académie* for 1775, 1789, and 1790, and particularly in his *Mécanique céleste.*

After having established the conditions of equilibrium for a point acted upon by any given number of forces in any given directions, M. Laplace considers the conditions of the equilibrium of fluids; the property which characterises them being perfect mobility, it follows of course, that for a fluid mass to become in equilibrium, it is necessary that each of the molecules that compose it be in equilibrium by virtue of the forces that influence it. From this principle, therefore, he determines the relation that should exist between the forces acting on the system, in order to the fulfilment of this condition; and he applies it to the equilibrium of a homogeneous fluid

fluid mass surrounding a solid nucleus fixed, and of any given figure.

He afterwards introduces into his differential equations the forces which disturb the state of equilibrium. These forces are, first, the attraction of the sun and moon; second, the attraction of the aqueous bed, of which the interior radius is that of the spheroid in equilibrium, and the exterior radius that of the perturbed spheroid.

Taking first upon the supposition of the earth being spherical without any rotary motion, and the depth of the sea every where the same, he seeks for the oscillations that in such a case would be excited by the united action of the sun and moon.

The integration of the differential equations presenting many difficulties, the author limits himself to a case of great extent, which is the supposition that the depth of the sea is only a function of the latitude. In this case even the investigation of the radius of the spheroid conducts to a linear differential equation, of which the integration surpasses the forces of analysis; but the author observes, that in order to determine the oscillations of the ocean, it is not necessary to integrate this equation generally, and that it is sufficiently satisfactory, because the parts of these oscillations, depending on the primitive state of the sea, would soon have disappeared, from the effect of the exterior obstacles; so that without the action of the sun and moon, the sea would long since have arrived at a state of permanent equilibrium; whence it follows, that the action of these two luminaries agitates it incessantly, and that it is sufficient to consider thus the oscillations which depend on such action.

As

As he proceeds to develope the terms that produce them, M. Laplace divides them into three classes; the first not at all depending on the rotary motion of the earth, but solely on the motion of the attracting body in its orbit; they vary very slowly, and do not become the same again until after a long interval. The terms of the second class depend principally on the rotary motion of the earth, and become the same again after an interval of nearly a day; lastly, those of the third class depend on a double angle, and consequently return in like manner after in half a day. Hence result three different kinds of oscillations, the periods of which are the same as those of the terms that produce them; the increase of the radius of the spheroid being given by a linear equation, these oscillations are superposed without being confounded, which permits the author to consider them separately.

He proceeds to examine the first, supposing the earth to be a revolving ellipsoid, which renders the depth of the sea a function of the latitude only; and he demonstrates that if the attracting luminary be at a sufficient distance, these oscillations may be calculated as if the depth of the sea were nearly the same in every part; the portion of these oscillations which depends on the motion of the nodes of the lunar orbit, may be very considerable; but the author demonstrates that these great oscillations are almost entirely annihilated by the resistance that the sea meets with in its motion, and that they are very nearly the same as if the sea were placed at each instant in equilibrium under the luminary that attracts it: this result becomes the more exact, as the attracting luminary moves more slowly in its orbit; the error is consequently insensible with respect to the sun;

and

and the observations indicating that the oscillations of this class are very small, the same consideration may be applied to the moon, notwithstanding the rapidity of her motion.

M. Laplace next proceeds to develope the terms produced by the second species of oscillations, which depend principally on the rotary motion of the earth.

This observation is here very important, and becomes even indispensable to enable us to deduce from these terms a law of the depth of the sea. It affords the means of expressing in a very simple way the oscillations of this species, when the spheroid is a revolving one. From these oscillations proceed the difference of the tide in one and the same day. This difference is very small, as the observations indicate; whereas in the ordinary hypothesis, the difference would be very great: it is necessary, therefore, that the depth of the sea be nearly constant. The author determines, on this hypothesis, the oscillations that he has examined.

He calculates, on the same supposition, the oscillations of the third species; observing afterwards that the resistance which the sea experiences in its movements, renders those of the first species independent of the law of its depth, he concludes that it is only necessary to consider those laws of the depth of the sea, by which we may determine at once, the oscillations of the second and third species; which reduces it to the supposition that the depth of the sea is nearly uniform. He gives, in this hypothesis, the numerical expression of the oscillations, and of the flux and reflux of the sea according to various suppositions with regard to depth.

Having thus determined the oscillations of the sea, by supposing the earth to be a spheroid of revolution, the

author approaches nearer to nature by giving the earth any form whatever; and he establishes the equations of the motions of the sea, whatever be the law of its depth.

In this case the oscillations of the first order, almost annihilated by the resistance the sea experiences, will be the same as before.

With respect to the other oscillations, he proposes to determine the laws of the depth of the sea, in which they may become nothing all over the earth; to accomplish this he equals to Zero the variation that they introduce in the radius of the spheroid; he deduces from it, first, that the oscillations of the second order cannot disappear all over the earth, except in the case where the depth of the sea is every where the same.

Secondly, That the disappearance of the oscillations of the third order would suppose the depth of the sea to be infinite at the equator, and nothing at the poles; so that there is no admissible law that can annihilate them entirely. The author afterwards, by applying to the general hypothesis of an indeterminate depth, the analysis that he employs when the enveloped spheroid is one of revolution, obtains the approximate expression of the height to which the action of the sun and moon raise the molecules of the sea above its surface of equilibrium, and this formula, which is much more general than the preceding, embraces also a great many phenomena which nature presents to us, and which escape notice in the case where the depth of the sea is merely a function of the latitude. Such is the difference between the hour of the tide and the passage of the body which produces it over the meridian; a difference which may and ought to be variable at different ports. But notwithstanding its generality, the preceding formula is still insufficient

sufficient for all observations; and it is not astonishing, when we consider the irregularity of the borders of the ocean, and the variety of resistances that it experiences; causes which it is impossible to reduce to calculation, and which obviously modify the oscillations of this mass of fluid. Hence the author concludes, that he must limit himself to the analysis of the general phenomena resulting from the attraction of the sun and moon, and to deducing from his observations on them, the data which are indispensable to complete, in every port, the theory of the flux and reflux of the sea.

In consequence, he takes the estimate previously obtained of the forces that give motion to the molecules of the sea, and he decomposes them into three other forces; the first directed according to the terrestrial radius; the second perpendicular to this radius and the plane of the meridian; the third perpendicular to that plane. Considering afterwards the action of the sun, as supposed to move uniformly in the plane of the equator, and always at the same distance from the centre of the earth, he observes that the forces resulting from this attraction, are composed of two parts; one independent of time, and invariable with regard to the molecules situated in the same latitude; the other depending on the motion of the earth and the position of the luminary in its orbit; and as the constant parts of these forces must necessarily occasion a little alteration in the permanent figure which the sea assumes in consequence of the rotary motion of the earth, the author confines himself to the consideration of the variable parts which cause the oscillations of the fluid. He then establishes this general principle, that the state of a system of bodies, in which the initial conditions of motion have disappeared in consequence

the resistance opposed to them, is periodical, as well as the forces that actuate them; and as the variable forces of which we have been speaking return to the same state in half a day, he concludes that there must be a flux and reflux in this interval.

Thus if we suppose a curve of which the abcissas represent the time, and the ordinates the corresponding elevations of the sea, the part of the curve corresponding to the abcissa, which represents half a day, will determine the entire curve, which will be the indefinite repetition of that first part.

To determine this curve, we must suppose a second sun, perfectly similar to the first, and moving in the same manner in the plane of the equator, with this single difference, that it precedes the first sun by a certain angle. After having estimated the forces resulting from the action of this second sun, we must suppose a third, of which we determine the mass and the position, and which would alone produce the same effect as the two others, and if all other circumstances are the same, and the elevation of the sea should be proportional to the mass of the bodies that produce it, we easily obtain the elevation corresponding to the third sun in functions of the height that the first sun would produce in the same position; but from the nature of the infinitely small oscillations that are superposed without being confounded, the elevation of the sea caused by the action of the two first suns, is equal to the sum of the elevations that each would produce separately; making this sum equal to that which the hypothesis of the third sun gives, there results a linear equation of finite differences between three ordinates of the curve of elevations of the sea. The author fulfils the conditions of this equation by

by the theorem of Dr. Brook Taylor, which serves to develope a function according to the powers of the variable, by means of differentials of different orders (*Methodus Incrementorum*), and thence deduces the expression of the height of the sea, which he constructs very elegantly. This expression includes two arbitrary quantities, of which the first depends on the magnitude of the full tide in the port under consideration, and the second on the hour of such high tide, or on the time in which it follows the passage of the sun over the meridian.

It appears at first sight that the hour of the tide ought to coincide with the passage over the meridian of the body that produces it, and that it would in fact take place if the earth were a revolving spheroid; but this is not the case in reality. To perceive the reason of this, it must be observed, that the phenomena of the tides are very sensible in a large mass of fluid, because the impression that each molecule receives is communicated to the whole mass, and must be scarcely sensible in lakes and small seas, such as the Caspian and Black seas. If therefore we suppose a large canal communicating with the sea and advancing very far into the lands situated under the meridian of its mouth, the flux and reflux belonging to this canal would be insensible at those places, but not so at the mouth itself; and the undulations produced at this extremity being successively continued to the whole length of the canal, would form at each of its points a flux and reflux subject to the same laws, but reaching them at later hours in proportion to their distance from the mouth.

M. Laplace then considers the action of the moon, supposing it to move uniformly in the plane of the equator,

equator, and always at the same distance from the centre of the earth; it is evident that a flux and reflux must result from it similar to that produced by the sun: he estimates it in the same manner, and combines the two oscillations, which being very small, by reason of the terrestrial radius, are superposed without being confounded; and he thence deduces the expression of the total elevation of the tide, which, according to what has been said above, includes four arbitrary constant quantities. This elevation is the greatest, when the two lunar and solar tides coincide; and it is least, when the high tide of the body that produces the greatest effect coincides with the low tide of the other. If then the solar tide exceeded the lunar tide, the maximum and the minimum would take place at the same hour of the day: in the contrary case the least tide would take place at the instant of the low solar tide, and would consequently be a quarter of a day later than the great tide. This furnishes the author with a simple method of ascertaining whether the lunar or solar action is the greatest; and all the observations prove that it is the former.

If we suppose, as before, a large canal communicating with the sea, it is obvious that it must take a certain length of time for the oscillations that take place at its mouth to make their way to its extremity; and as this time will approach more or less an equality to an exact number of lunar or solar days, the lunar or solar tides at this extremity will approximate also more or less to the hour in which the bodies that produce them arrive at the meridian. Hence we see how necessary it is in the theory of the tides to attend to the local circumstances of the port; and the consideration of the curve of the elevations of the sea, by introducing arbitrary quantities

quantities dependent on these circumstances, forms a very simple method of doing this. Laplace also shews that it is equally necessary to attend to them, in order to determine, by the phenomena of the tides, the attractive forces of the sun and moon. He then applies these formulæ to a case in which he supposes the above-mentioned canal to have two mouths, so situated that it shall be high water at the first at the same time that it is low water at the second, and reciprocally; and he demonstrates that if the two tides reach the extremity of the canal at the same time, there will be no flux and reflux at this extremity by reason of the oscillations whose period is half a day. This singular case, which depends entirely on local circumstances, has been observed at Batsha a port in the kingdom of Tonquin, and in some other places.

The author then considers the case in which the sun and moon, always moving in the plane of the equator, would be subject to inequalities in their motions and in their distances; and lastly he passes to the case actually occurring in nature, in which we must pay attention to the declination of these luminaries. He shews that this general case may, as well as the preceding, be applied to that of several other bodies moving uniformly in the plane of the equator, but at different distances from the centre of the earth, and with different velocities in their orbits. Combining these partial actions, he concludes that in the system of nature in which these luminaries move in orbits inclined to the equator, the elevation of the tide is owing to the attraction both of the moon and sun.

This expression occasions two sorts of phenomena, one relative to the height of the tides, the other relative

tion to their intervals. In order to compare them with the observations, the author considers them at their maximum towards their syzygies; and at their minimum towards the quadratures. The observations that he employed were collected from those that were made at Brest, on the invitation of the Academy of Sciences, for six successive years, and which M. Lalande has published in his *Treatise of Astronomy*. M. Laplace examined with the utmost care all those that he employed.

Among the phenomena that the system of the universe afford us, there are few of more importance than the flux and reflux of the sea; an accurate acquaintance with it is not only serviceable to the daily business of sea-ports, but it is also useful to prevent the accidents that might result from the inundations of the high tides towards the syzygies. This result of the celestial attraction has, besides, the advantage of serving to confirm, in the most positive manner, the theory of universal gravity, which the author is particularly careful to establish, by recurring with much ability to the striking coincidence of the observations with the theory. The result of this comparison is, that at Brest the influence of the moon on the phenomena of the tides is nearly treble that of the sun. This theory is one of the most interesting in his great work the *Mécanique Céleste*; we there find every thing that is necessary to be applied to practice at different ports, the phenomena that it concerns us to follow, and whose elements are still dubious; lastly, it would be difficult to find a more excellent model of that important art, which consists in examining the phenomena, and extricating by skilful combinations and expedients those we are desirous of examining. We have spoken thus on this work, in order to shew, both the difficulties

difficulties the author has surmounted, and the importance of his theory which is as new as it is difficult.

M. Laplace has been also desirous of determining whether the sea can have any influence on the motion of the earth, on account of the aqueous bed, which through the attraction of the sun and moon, is deposited on the surface of equilibrium of the sea. He estimates these forces, substitutes them in the equations of solid bodies, investigates them, and demonstrates that they are the same as if the sea formed a solid mass with the spheroid that it surrounds.

The preceding analysis, although very general, supposes that the sea entirely covers the terrestrial spheroid, that its depth is uniform, and that it experiences no resistance from the spheroid that it encloses. These suppositions might cause a doubt that the preceding results actually take place in nature. The author, therefore, gives a second demonstration independent of these hypotheses.

The principle of areas, which the author has often employed, has here the advantage of being equally true, when the system experiences any changes or sudden movements, as is often the case with the sea when it happens to break against rivers. If the body be subject to the action of foreign forces, the sum of the areas described during the element of time is no longer a constant quantity, but it is easy to obtain its variation, which is independent of the mutual connexion of the parts of the system. This being admitted, we may suppose a mass, partly fluid and partly solid, to be deranged from the state of equilibrium by the action of very small forces, which leave the centre of gravity at rest; the sum of the areas described during the element of time will be (nearly to quantities of the second order) the same as if

the mass had been entirely solid. Hence it follows, that after any time whatever the amount of the areas will still be the same on the two hypotheses.

This being admitted, considering the earth as a revolving spheroid, very little different from a sphere, and surrounded by a fluid of little depth, the author estimates the sum of the areas in the two cases above-mentioned; and on equating these sums, he infers that the motion of the earth round its centre of gravity is the same as it would be if the sea formed with it one solid mass. He then extends this demonstration to the case in which he supposes the earth to be of any given form.

After having established this excellent theorem, M. Laplace proceeds to examine whether the trade winds which constantly blow from West to East between the tropics, do not alter the rotary motion of the earth by striking against the continents and mountains they meet with; but the principle of areas soon shews that these winds, which are produced by the solar heat, cannot have such an effect; as this heat dilating the body equally on every side, the amount of the areas is not altered; so that while the trade-winds at the equator diminish the rotary motion of the earth, the other motions of the atmosphere, which take place beyond the tropics by virtue of the same cause, accelerate the motion in the same proportion. The author applies this reasoning to earthquakes, torrents, and generally to whatever is likely to agitate the earth in its interior and at its surface; and he concludes that these causes do not at all disturb the rotary motion of the earth, which can only be altered by the displacing of its parts; but this effect, to be sensible, would argue great changes in its internal constitution.

The

The invariability of the rotary motion of the earth is of the greatest importance; since the length of the days depend on it. This theorem and the author's previous researches, in which he determines the effect of the re-action of the waters of the sea on the axis of the earth, are very proper to shew the extent and power of analysis, and the degree to which it has been carried in the eighteenth century.

Intelligence relating to Arts, Manufactures, &c.

(Authentic Communications for this Department of our Work will be thankfully received.)

An Account of the Wool purchased in foreign Countries in the Years 1802, 1803, *and* 1804, *and employed in Great Britain for the Manufacture of the finest Woollen Goods. In this Statement is included the probable Expense to this Country of the Wool so purchased.*

IN the three years specified, there were imported, of Spanish wool, directly from Spain, 16,986,644 lbs.

Holland,	403,400
Portugal,	400,723
Gibraltar,	288,274
France,	252,222
Germany,	122,150
America,	10,567
Prussia,	3,357
Denmark,	381
Total	18,467,718 lbs.

Of this quantity, about 15,307,718 lbs. were imported in Spanish or neutral vessels, and the remaining 3,160,000 lbs. in English vessels.

Of the quantity imported in Spanish or neutral vessels, about 15,141,900 lbs. were sheep's wool, and 165,778 lbs. lambs wool. Of the sheep's wool the proportions were, of the R, or first sort, about 12,000,000 lbs.; of the F, or second sort, about 2,000,000 lbs.; of the T, or third sort, about 1,127,000 lbs.; and of the K, or coarsest sort, about 14,920 lbs.

The average prices given for these wools by the clothiers in England were nearly as follows:

		£.
R, sheep's wool,	12,000,000, at 6*s.* *per* lb.	3,600,000
F, ditto,	2,000,000, at 5*s.*	500,000
T, ditto,	1,127,020, at 4*s.* 6*d.*	253,579
K, ditto,	14,920, at 3*s.*	2,238
Lambs wool,	165,778, at 4*s* 3*d.*	35,227
	15,307,718 lbs.	£. 4,391,044

These £4,391,044. were the sum paid by our clothiers for this wool. What the merchants' profit might be is not presumed to be determined; but if we allow 15 *per cent.* inclusive of interest, or £658,656. the remainder, or £3,733,288. will be the sum actually paid out of the kingdom for this part of the imported wool.

Besides these quantities, there were imported in British vessels about 3,160,000 lbs. of Spanish wool; of which the respective proportions were, probably, nearly as follows:

R, sheep's wool,	2,477,182 lbs.	at 6*s.*	£.743,154
F, ditto,	412,864	at 5*s.*	103,216
T, ditto,	232,652	at 4*s.* 6*d.*	52,346
K, ditto,	3,079	at 3*s*	461
Lamb's wool,	34,223	at 4*s.* 3*d.*	7,272
	3,160,000		£.906,449

From

From the gross amount of the latter sum, which is what is paid by the manufacturer, there must in this case be deducted not only the merchant's profits, but also the expenses of freight and insurance. These cannot with any accuracy be stated.

There were brought into England within the same period from Germany, 561,604 lbs. of wool not called Spanish, but a great deal of which was of the same quality.

There is the same difficulty with regard to 613,059lbs. of wool imported from Africa and the Cape of Good Hope.

From Portugal there came also 486,124 lbs. the greater part of which was probably equal to the third, or even the coarser second sorts of Spanish wool.

From these data, gross as some of them are, little doubt can be entertained, that during the three years in question, Great Britain paid to foreign countries for the wool which was the chief basis of its fine woollen manufactures, at least £4,700,000. or upwards of £1,560,000. *per annum.*

List of Patents for Inventions, &c.

(Continued from Page 384.)

SAMUEL THOMSON, of Addle-street, in the city of London, Callenderer, for a machine, engine, or frame, for the purpose of widening or stretching to the width, leather, cloth of linen, cloth of cotton, cloth of woollen, or of a mixture of either brown, bleached, printed, stained, or dyed, and all descriptions of piece goods. Dated March 3, 1808. Specification to be enrolled within one month.

RICHARD

RICHARD WILLCOX, of the parish of St. Mary Lambeth, in the county of Surrey, Mechanist, for certain machinery or apparatus whereby all objects in the sea or clear water can be discovered from the surface thereof with accuracy; and for raising, suspending, and towing into harbour, ships of war and every other description of vessels that are or may be sunk at sea, or near the sea-coast, channels, harbours, roadsteads, or other places, and removing sunken rocks, or other obstructions in rivers, harbours, and channels. Dated March 3, 1808. Specification to be enrolled within twenty months.

FREDERIC ALBERT WINSOR, of Pall-Mall, in the county of Middlesex, Esq. for certain improvements upon his former patent oven, stove, or apparatus, for carbonising all sorts of raw fuel and combustibles, and reducing them into superior fuel of coke and charcoal, as well as for extracting and saving during the same process the oil, tar, pyroligneous vegetable acid, and ammonial coal liquors; and for extracting and refining all the inflammable air or gas so as to deprive it of all disagreeable odour during combustion, and rendering the gas itself salutary for human respiration when properly diluted with atmospheric air; and various methods of applying the above products to useful purposes. Dated March 3, 1808. Specification to be enrolled within six months.

JOHN COWDEN and JOHN PARTRIDGE, of Francis-street, Tottenham-court-road, in the county of Middlesex, Stove-grate-manufacturers, for certain improvements in register and other stoves. Dated March 3, 1808. Specification to be enrolled within one month.

THOMAS

THOMAS JEFFERSON, of the parish of St. Saviour Southwark, in the county of Surrey, Tanner and Leather-dresser, JOSEPH ELLIS, of the parish of St. Saviour aforesaid, Tanner and Leather-dresser, and ALEXANDER GALLOWAY, of Holborn, in the county of Middlesex, Mechanist and Engineer, for a machine or machines for the purpose of finishing, glazing and glossing of leather. Dated March 7, 1808. Specification to be enrolled within one month.

MARC ISAMBARD BRUNEL, of Chelsea, in the county of Middlesex, for certain improvements on circular saws for sawing wood in an easy and expeditious manner. Dated March 14, 1808. Specification to be enrolled within six months.

HENRY MAUDSLAY, of Margaret-street, Cavendish-square, in the county of Middlesex, Mechanist, for a machine or machines for printing calicoes and other articles. Dated March 14, 1808. Specification to be enrolled within four months.

BRYAN DONKIN, of Fort-place, Bermondsey, in the county of Surrey, Gent. for a pen upon a new construction. Dated March 14, 1808. Specification to be enrolled within one month.

GEORGE NATHANIEL POLLARD, of Queen-street, in the county of Surrey, Lapidary, for certain improvements in machinery for grinding, smoothing, and polishing, plate and other glass for looking-glasses, mirrors, and various other articles. Dated March 14, 1808. Specification to be enrolled within two months.

EDWARD WEEKS, of Llaveny Hall, in the parish of Henlan, and county of Denbigh, in North Wales, Gardener,

dener, for a forcing-frame on a new and improved construction for raising and forcing of cucumbers, melons, strawberries, and various other fruits and plants which require the application of artificial heat to rear or ripen the same. Dated March 17, 1808. Specification to be enrolled within one month.

ANTHONY THOMAS, of Duke-street, Saint James's, in the county of Middlesex; for a method of manufacturing hats, bonnets, and other articles of the like description. Dated March 26, 1808. Specification to be enrolled within one month.

BENJAMIN COOK, of Birmingham, in the county of Warwick, Manufacturer; for a method of making barrels for fowling-pieces, muskets, pistols, and other similar fire-arms, and ram-rods for the same. Dated March 28, 1808. Specification to be enrolled within six months.

JOHN DICKSON, of Edward-street, in the county of Surrey, Engineer; for a method of constructing cocks for stopping fluids; and which cocks, by one motion or operation, will permit such fluids to pass in different directions. Dated March 29, 1808. Specification to be enrolled within one month.

END OF THE TWELFTH VOLUME, SECOND SERIES.

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